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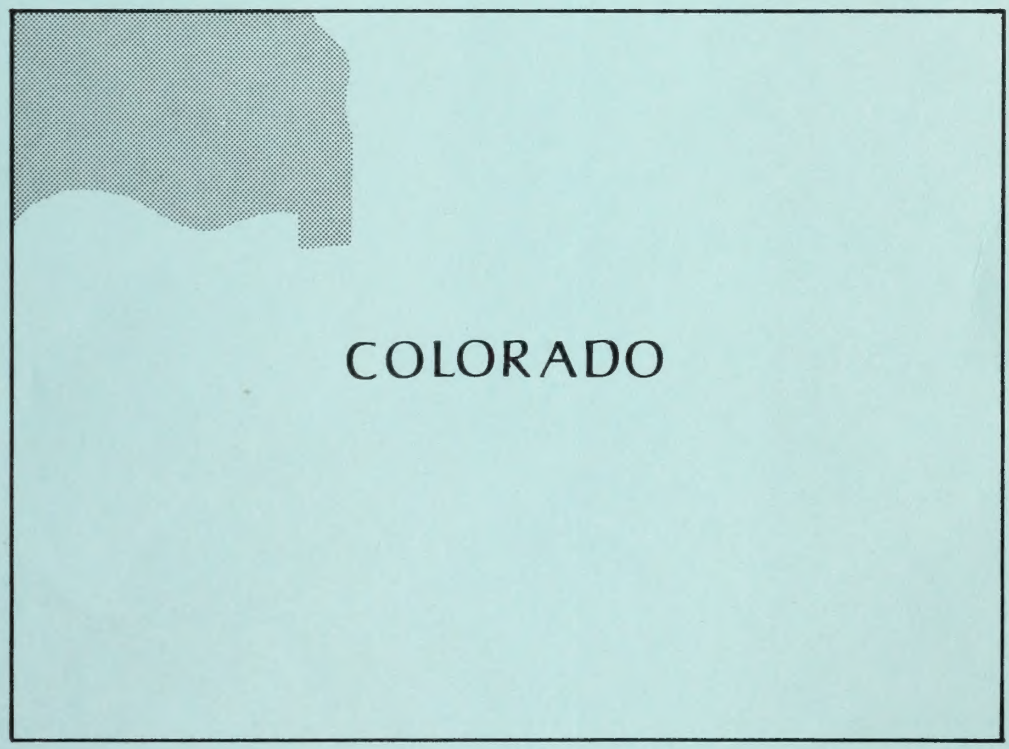
A SUPPLEMENT TO THE NORTHWEST COLORADO COAL REGIONAL ENVIRONMENTAL STATEMENT



U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

NOTICE

The following document is not an environmental statement, but an environmental report which updates a final regional environmental statement published in January 1977, the Northwest Colorado Coal Regional Environmental Statement FES 77-1 (NWCCRES).

Because this document is a report rather than a full-fledged environmental statement, it will not be submitted for formal review as is normally required for ESs. Comments regarding any aspect of this report will be accepted, however, and will be used in any future environmental analysis pertaining to the study area.

Comments should be addressed to the NW Supplemental Report Team, c/o Craig District Office, Bureau of Land Management, Box 248, Craig, Colorado 81625.

Dale R Andrus

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CHAPTER 1

DESCRIPTION OF PROBABLE FUTURE DEVELOPMENT

INTRODUCTION

Scope

In June 1977, the Bureau of Land Management (BLM) in Colorado was directed to prepare a supplement to the Northwest Colorado Coal Regional Environmental Statement FES 77-1 (NWCCRES) that was published in January 1977. This supplemental environmental statement (ES), which was to be called the Northwest Supplement, was to have assessed the site-specific environmental impacts of 15 short-term competitive lease areas and existing preference right lease applications. In addition, the supplemental ES was to include a regional cumulative assessment of potential areas of new federal coal development (as identified though BLM's planning system), existing federal coal leases with no developments or mine plans, and already existing mining operations in addition to the 15 proposed applications. This assessment was to indicate the area-wide environmental conditions and potential impacts of further coal development in northwest Colorado.

In the September 27, 1977, decision of the U.S. District Court of the District of Columbia in Natural Resources Defense Council, Inc. (NRDC) v. Royston Hughes, the Department of the Interior and BLM were enjoined from taking any steps to implement new federal coal leasing until a new programmatic environmental statement is prepared correcting the deficiencies in the original September 1975 programmatic ES. This court order removed new leasing from consideration in the ongoing regional environmental statements except for short-term leases meeting the standards described in the U.S. District Court's decision as amended on June 14, 1978.

Since there can be no new federal leasing of coal at this time, and since none of the 15 tracts in northwest Colorado that were applied for by industry as short-term areas meet the short-term leasing standards of the U.S. District Court decision, there is no proposed federal action requiring a supplemental environmental statement. It was necessary, therefore, to change the thrust of the supplement that was already under preparation at the time of the September 1977 court decision to a study report (hereafter referred to as the Northwest Supplemental Report). This Northwest (NW) Supplemental Report will provide the following: (1) an update of the environmental conditions in northwest Colorado in relation to coal development that is occurring within the region; (2) an update of the assessment of impacts that reflects new laws and regulations that have become effective since the NWCCRES was originally prepared. These especially include the Surface Mining Control and Reclamation Act of 1977 (SMCRA) (P.L. 95-87) and the 30 CFR 700 initial regulations for surface

coal mining and surface effects of underground coal mining, and the Federal Land Policy and Management Act of 1976 (FLPMA) (43 USC 351-359); (3) a regional cumulative analysis of federal coal development that may occur in northwest Colorado through 1990; and (4) input to the new programmatic ES.

Given the current national trends in energy policy development, coal will probably have an increasing role in future energy development and, specifically, coal resources in northwest Colorado. The degree to which coal will be developed in coordination with research, development, and utilization of other energy sources such as oil and natural gas, oil shale, and nuclear and solar energy could vary a great deal. Therefore, an additional approach to the regional analysis of coal development from that appearing in the NWCCRES will be to describe the practical limits, as far as they can be projected, of the spectrum of coal development that could occur in northwest Colorado. This spectrum will be described in three levels of coal development and their respective levels of impacts, where they occur. They are: (1) no additional federal actions (low-level), (2) a "most likely" level of coal development (mid-level), and (3) a full (high-level) development of coal. The scenarios of low-level and high-level production projections will be discussed in detail in Chapter 8. The main body of the report will address the mid-level or "most likely" scenario.

The mid-level portion of the supplemental report will analyze the cumulative impacts of: (1) projected production from non-federal (state and private) coal, (2) projected production from existing federal coal leases with existing approved mine plans, (3) production from new mines or existing mines on issued federal leases which would need mine plan approval, (4) production of non-federal coal that would be induced by federal development, (5) sustained production of existing and scheduled mines from future federal short-term leases that may be issued under short term standards, and (6) development of related rights-of-way and other coal-related development.

Where applicable, the NW Supplemental Report will identify and make reference to previous material analyzed in the NWCCRES (FES 77-1) and the Yampa Project Environmental Statement (U.S. Department of Argiculture (USDA) ES-74-2-F). This material will not be repeated in the analysis portion of this report, but its previous evaluation will be noted and its importance will be summarized and incorporated in order to provide as complete a perspective as possible concerning the federal role in coal development in northwest Colorado. This supplemental report will also utilize additional information from the BLM planning system and information provided by industry and other interested parties. In addition, Chapter 1 of the report will contain data on projected production from non-federal coal as estimated by the study team from the limited information available.

The time frame for analysis of the impacts of projected coal development in northwest Colorado will be carried over from the NWCCRES. Specific points of analysis will be made for 1980, 1985, and 1990.

Environmental Study Area

This report will cover the same area as the NWCCRES. This is Moffat, Routt, and Rio Blanco counties north of the White River in northwest Colorado, covering approximately 5.68 million acres of private, state, and federal lands (See Figure 1-1). This area is considered the region of primary and secondary impacts that would be associated with possible future development of federal coal. It includes the Yampa River drainage and the north half of the White River drainage as well as the major socio-economic centers of the area. This area is hereafter referred to as "the study area."

Agency Role in Preparing the Northwest Supplemental Report

This report was prepared by the Bureau of Land Management (BLM) assisted by the U.S. Geological Survey (USGS). BLM was designated the lead agency on the Northwest Supplemental Report and is responsible for preparing the regional analysis.

Future NEPA Review Points

The report does not propose new federal coal leasing nor does it commit the Secretary of the Interior to a new federal coal leasing program or to the issuance of new federal coal leases. However, some short-term coal leases that meet current standards as defined in the June 14, 1978, amended court order of NRDC v. Hughes may be issued in the future in the study area. These and other actions would require additional environmental assessment to comply with NEPA.

Examples of coal-related actions requiring environmental analysis under NEPA include:

1. Issuance of federal coal leases under current short-term standards.

2. Approval of exploration and/or mining and reclamation plans not previously examined site specifically in the NWCCRES, including new plans on existing leases and modifications of existing operations on federal leases.

3. Approval and issuance of applications for rights-of-way for ancillary facilities, including roads, railroad spurs, powerlines, telephone lines, water pipelines, and conveyor systems to be constructed on federal lands outside the immediate area of operations.

4. Exchange or replacement of unleased federal coal for leased federal coal located in areas of high environmental concern, pursuant to the Federal Coal Leasing Amendment Act (FCLAA) and regulations published December 23, 1977 and February 27, 1978.

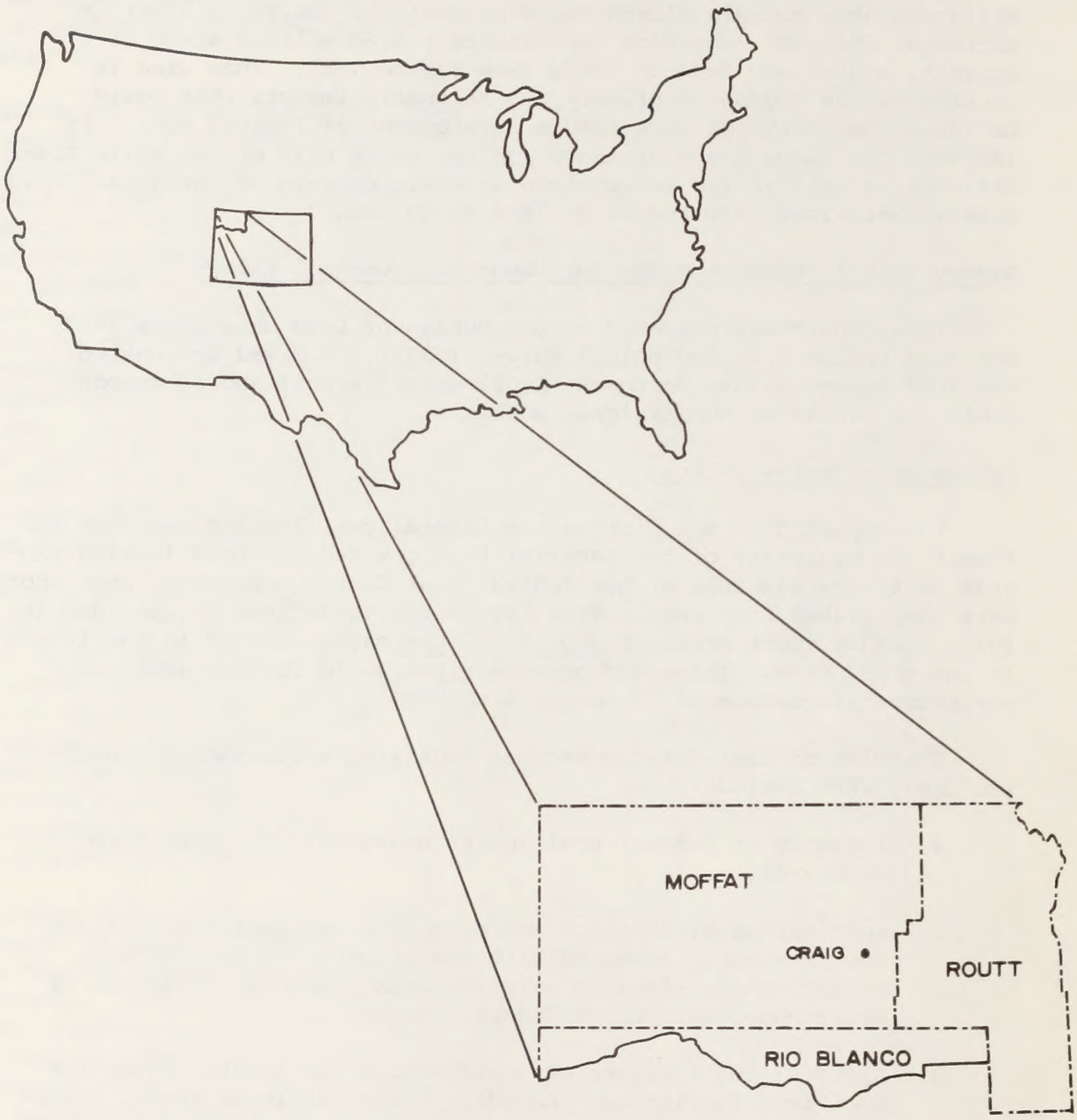


Figure 1-1.

Northwest Supplemental Study Area.

Required Authorizations

Department of the Interior Agencies

U.S. Geological Survey. The area mining supervisor is authorized, under 30 CFR 211, to approve exploration plans, provided all necessary surface and environmental protection conditions have been adequately considered. Review of the Secretary of the Interior is required prior to approval of proposed actions determined to be major federal actions significantly affecting the quality of the human environment, and is required for all new or significantly modified surface and underground coal mining operations on federal lease lands.

The USGS is also responsible for formulating development, production, and coal recovery requirements included in mining permits, to assure that there is maximum economic recovery of the federal coal resource and that the federal government receives fair market value for the coal.

Bureau of Land Management. BLM develops the special requirements to be included in federal coal leases and reclamation plans related to management and protection of all resources other than coal and the post-mining use of the affected lands. BLM is also responsible for granting various rights-of-way for ancillary facilities such as access roads, powerlines, communication lines, and railroad spurs on public lands.

Office of Surface Mining Reclamation and Enforcement (OSM). OSM, with concurrence of the surface managing agency (BLM) and USGS, recommends approval or disapproval of a mining and reclamation plan to the Assistant Secretary of Energy and Minerals. Whenever a state has entered into a state-federal cooperative agreement with the Secretary of the Interior, in accordance with section 523 (c) of the Surface Mining Control and Reclamation Act (SMCRA), the state regulatory authority and OSM will jointly review exploration plans on existing leases and mining and permit applications. Both agencies will recommend approval or disapproval to the officials of the state and department authorized to take final action on the permit.

Appendix A, Section 1, contains a complete listing of the regulations requiring federal and State of Colorado permits to mine coal.

Other Federal Agencies

The Environmental Protection Agency (EPA), administering both the Clean Air Act and the Federal Water Pollution Control Act, ensures that any entity proposing a new industrial facility (e.g., fossil fuel-fired steam generators) obtains a permit certifying that the plant complies with EPA's new source performance standards. In Colorado, these authorities have been delegated to the State Air Pollution Control Commisssion and the State Water Quality Control Division, both of the Colorado Department of Health.

The Mining Safety and Health Administration (MSHA) of the Department of Labor enforces federal health and safety standards in all mining operations, including approval of roof control and ventilation plants for underground mines. Regulations enforced by MSHA appear in 30 CFR 77.

The Department of Labor Occupational Safety and Health Administration (OSHA) is responsible for enforcement of the Employee Safety and Health Act of 1970, which applies to surface structures and facilities of underground coal mining operations.

The Department of Army Corps of Engineers is responsible for ensuring compliance with Section 404 of the Federal Water Pollution Control Act and Section 10 of the River and Harbor Act of 1899. These regulations are contained in 33 CFR 209.12 and require issuance of permits for a wide variety of actions relating to crossings of navigable streams and alteration of stream beds.

The Department of Energy is responsible for setting coal production rates and reviewing stipulations included in federal coal leases and establishing diligence requirements for each lease.

State of Colorado Agencies

The Division of Mines of the Colorado Department of Natural Resources requires the filing of a notice of activity for any proposed exploration or mining in the state. The division also monitors mine safety practices in concert with MSHA; common procedure is for the state to conduct the monitoring with MSHA supervision.

The Land Reclamation Board of the Division of Mines issues a permit based on an acceptable plan of activity, application fee, and performance bond. The plan must comply with the Colorado Open Mining Land Reclamation Act, as amended in 1973, which sets standards, practices, time factors, and reporting procedures. A cooperative agreement between the Department of the Interior and the Colorado State Mine Reclamation Board has been recently established and is included in Appendix A, Section 2. This agreement will be modified to incorporate coordination with the Office of Surface Mining concerning joint state and federal review of mine plans.

The Water Pollution Control Commission of the Colorado Department of Health has regulatory authority over water quality and related health hazards during construction and operation phases. Standards are a matter of state law, and permits are required. The commission works in concert with EPA. The Air Pollution Control Commission of the Department of Health performs a similar role with respect to air quality.

The Colorado Public Utilities Commission (PUC) works in concert with Interstate Commerce Commission (ICC) in matters involving railroad construction and abandonment. Of particular concern to PUC is the crossing of a public road by a railroad; approval is required for the location and safety features of a crossing.

The State Highway Department also is concerned with railroad crossings of state and federal highways and with any impingement on those road systems, including forces that will tend to significantly increase traffic volume or load tonnages.

The State of Colorado requires licenses for all contractors. Refer to Appendix A, Section 1, which details regulations requiring issuance of state permits.

County Agencies

Moffat, Routt, and Rio Blanco counties require special use permits for operation of coal mines. For example, in Rio Blanco County, coal mining falls into the category of "conditional uses" of land which must be approved by the Board of County Commissioners subject to certain conditions. These conditions are designed "to protect the surrounding area and community" and include the requirements that the use be compatible with all existing uses on adjacent land, that the use not unnecessarily scar the land and soil, leaving deleterious effects such as denuded slopes, uncovered soil piles that can blow away, and scars upon areas of natural beauty or create adverse effects from noise and odor for adjacent property, and that the use not create air or water pollution.

Related Reviews

Environmental Protection

The interim final regulations for the Surface Mining Control and Reclamation Act (SMCRA) of 1977 (P.L. 95-87) were published in the Federal Register, Vol. 42, No.239, December 13, 1977, and Vol. 43, No. 39, February 27, 1978, and Vol. 43, No. 81, April 26, 1978. These regulations (30 CFR 700) establish environmental performance standards for surface coal mining and reclamation operations and requirements for surface effects of underground mining, and establish requirements and approval procedures for state programs. They also require the identification of lands unsuitable for surface coal mining, alluvial valley floors, and prime farmlands. Criteria for lands unsuitable and alluvial valley floors are being developed. Prime farmland surveys are being conducted, as discussed below.

Surface Owner Protection

Prior to approval of mining and reclamation plans, the companies would have to comply with Sections 714 and 715 of the SMCRA, which provides for protection of surface owner's rights where federal coal under private surface has been leased, and for protection of federal lessees who have existing rights on federal lands (such as pipeline rights-of-way, powerlines, etc.) that may be impacted by the coal mining.

Preference Right Lease Application Status Review

Preference right lease applications (PRLAs) are included in the high-level scenario. This differs from the NWCCRES where they were included in the anticipated production projections.

Preference right lease applicants were required to prepare an initial showing in accordance with the 43 CFR 3521 regulations indicating evidence of commercial quantities of coal. Initial showings were submitted by July 1977. The PRLAs will be evaluated in technical reports and environmental assessments to be prepared by BLM.

The Department of the Interior, however, may not issue any new coal leases including preference right leases until an injunction issued by the U.S. District Court for the District of Columbia in the case NRDC v. Hughes is removed. On September 27, 1977, the Department was enjoined from issuing any new coal leases until a new coal programmatic ES is issued correcting the deficiencies of the original September 1975 programmatic ES. The new statement is scheduled to be completed in final form in April 1979.

In an amended court order issued June 14, 1978, the U.S. District Court is allowing the Department of the Interior (and BLM) to issue 20 new preference right leases, under certain conditions. Those preference right leases must cause the least environmental impact of all preference right lease applications pending approval of the Secretary of Interior on June 14, 1978. In addition, those leases must be chosen for which at least 90 percent of the total reserve would be mined by underground rather than by surface methods and the total amount of surface mining would affect no more than 50 acres. Further, the mining and transportation of this new coal must not require substantial new transportation facilities or water storage or supply systems and must not involve substantial new industrial development in the area.

A Department of the Interior Solicitor's opinion interpreting the Mineral Leasing Act of 1920 has determined that areas of Federal coal under preference right lease application cannot be leased if there were existing mining claims under the Mining Law of 1872 at the time the prospectimg permit was issued. Preference right lease applicants are required to submit abstracts of any mining claims that may exist within the application area.

Department of Energy Review

The Department of Energy (DOE) under the Act of 1977 is authorized to set coal production rates on federal coal leases, review and concur on stipulations included in federal coal leases, and establish diligence requirements for each lease. Guidelines and procedures are being developed for coordination of DOE's responsibilities with those of the Department of the Interior.

Diligent Development and Continuous Operations Requirements

The Federal Coal Leasing Amendments Act of 1975 imposed diligent development and continuous operations requirements on all federal coal leases (final regulations published in the Federal Register, Vol. 41, No. 251, December 29, 1976). Although the requirements were essentially the same for all federal leases, those leases effective before August 4, 1976, were required to meet different criteria from leases issued after August 4, 1976.

All of the federal coal leases within the study area were issued and effective before August 4, 1976. The regulations which apply to these leases require the following:

1. That 2.5 percent of the logical mining unit (LMU) be produced by June 1, 1986 (the LMU is essentially the mine property, including all of the associated federal leases and private coal reserves).

2. That 1 percent of the LMU reserves be produced during each of the 2 years following the achievement of diligent development.

3. That an average of 1 percent of the LMU reserves be produced annually thereafter (average annual production is computed on a 3-year basis, using the year in question and the 2 preceeding years).

Although a number of exceptions to these requirements are stipulated in the regulations, in general, failure to meet the production level requirements would terminate the federal coal lease or leases in the LMU. At the present time no federal coal leases have been terminated in northwest Colorado.

Energy Minerals Rehabilitation Inventory Analysis

The Energy Minerals Rehabilitation Inventory and Analysis (EMRIA) program collects baseline information on reclamation potential for stipulations for coal lease agreements. This data is collected by the Bureau of Land Management, U.S. Geological Survey, Bureau of Reclamation, and the Soil Conservation Service.

Currently in northwest Colorado, there is one completed EMRIA report for the Taylor Creek study site in the Axial Basin coal field (EMRIA Report No. 3, 1975). In addition, reports are near completion for study areas at Foidel Creek and Fish Creek, to be published early in

1979. Information is being gathered for two additional sites, one near Lay, Colorado, and one near Walden, Colorado. In addition to the established reclamation study areas, there are two revegetation study trials, one at the Energy Fuels Corp. mine and one at the Pittsburg and Midway-Edna mine near Oak Creek, Colorado, designed to analyze problems specific to revegetation.

Determination of Prime Farmland

Under the Surface Mining Control and Reclamation Act (SMCRA) of 1977, 30 CFR 700, prime farmlands must be identified and special measures taken to mitigate the loss of their highly productive soil. Prime farmland is defined in the Surface Mining Control and Reclamation Act (SMCRA) and refers to lands that have been used for the production of cultivated crops, including nurseries, orchards, and other speciality crops, and small grains for at least 5 years out of the 20 years preceding the date of the permit application and meet specific technical criteria prescribed by the Secretary of Agriculture, which appeared in the Federal Register on August 23, 1977. These criteria include conditions relating to moisture and temperature regimes, pH, water table, soil horizons, permeability rate, flood conditions, and K-factor (30 CFR 716.7 (a), (b)).

The mitigation requirements for restoration of prime farmlands affected by mining are described in Chapter 3, Soils. The Soil Conservation Service (SCS) is responsible for determining where prime farmlands are located. At the present time, the SCS is conducting surveys, but no prime farmlands in the study area that would be affected by existing or potential federal coal development have yet been identified.

Identification of Alluvial Valley Floors

Regulations (30 CFR 715.17 (j)) pursuant to the Surface Mining Control and Reclamation Act of 1977 require that a permittee must identify and provide information to the Office of Surface Mining or an approved state agency about the essential hydrologic functions of alluvial valley floors and demonstrate that those functions will be preserved despite surface coal mining in the area. Surface mining cannot interrupt or discontinue farming on alluvial valley floors and must not materially damage the quantity and quality of surface or ground water that supplies these floors unless coal was produced in commerical quantities on or adjacent to them or unless a permit to mine that area had been issued by the state prior to August 3, 1977. Mining may be permitted on alluvial valley floors where premining land use was undeveloped rangeland or where the affected area is small and provides negligible support for one or more farms.

Regulations applying to alluvial valley floors in northwest Colorado and their significance are described in Chapter 3 Water Resources. Criteria for determining alluvial valley floors are currently being developed by the Office of Surface Mining (OSM) and should be completed in October, 1978.

Exploratory Drilling Activity

Exploratory drilling has been and is being conducted in northwest Colorado in existing and potential coal lease areas. Drilling on existing lease sites is done to determine precise location, thickness, and type of coal for the development of mining plans.

Under 43 CFR 3507.0-.2, coal exploration licenses for unleased land are issued to allow private parties to explore federally-owned coal deposits for geological, environmental, and other data. All lands subject to coal leasing administered by the Department of the Interior are available for exploration. Exploration activities on land leased for coal development are given approval by the USGS under 30 CFR 211.

Exploration for coal both on leased and unleased land has been extensive in the area covered by the Northwest Supplemental Report, which includes Moffat, Rio Blanco, and Routt counties. Companies with existing or pending licenses are AMCA Coal Leasing, Inc. and Pittsburg & Midway (south-central Routt County), Utah International (east-central Moffat County), and Northern Minerals Company and Consolidation Coal Company (northeast Rio Blanco County).

COAL DEVELOPMENT

Existing Coal Development

The coal production (for 1977) of nine companies in northwest Colorado is listed in Table 1-1. This table shows the coal produced from federal leases and coal produced from non-federal (state and private) lands. Total production for 1977 was 7,404,100 tons of which 2,860,000 tons were produced from federal leases.

Coal Production Projections

Three levels of potential development through 1990 will be analyzed in this report. They are: (1) no additional federal actions (low-level), (2) a "most likely" level of coal development (mid-level), and (3) full (high-level) coal development. The scenarios of projected low- and high-level production will be discussed in detail in Chapter 8. The following scenario is for the "most likely" or mid-level production. The impacts of this level are assessed in Chapter 4.

Table 1-2 presents the projected mid-level coal production for the study area through 1990. The following is a list of the assumptions made to obtain this level.

1. The mid-level includes all of the low-level production (Table 8-1, Chapter 8 - coal development that could proceed without additional federal action) plus additional federal coal described in the paragraphs below.

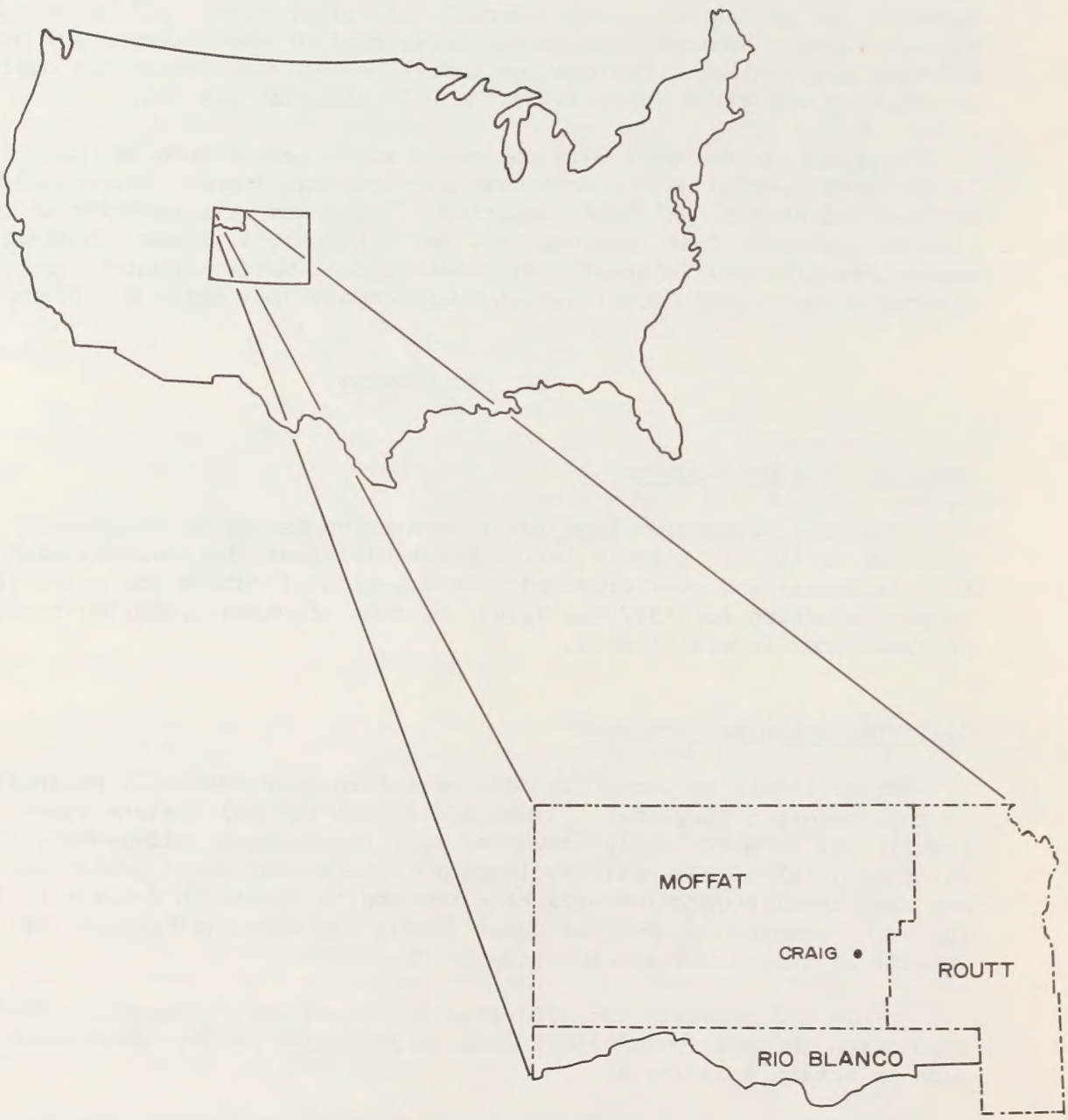


Figure 1-1.

Northwest Supplemental Study Area.

TABLE 1-2

PROJECTED MID-LEVEL COAL PRODUCTION IN THE STUDY AREA (1000s OF TONS)

Company	1980 F 3/	1980 NF 3/	1985 F	1985 NF	1990 F	1990 NF
AMCA	250	-	250	-	250 1/	-
Coal Fuels Corp.	-	1,000	-	2,000	-	2,000
Colowyo Coal Co.	3,000	-	3,000	-	3,000	-
Empire Energy	-	2,400	-	2,400	600 1/	1,800
Energy Fuels Corp.	4,000 1/	-	4,000	-	4,000	-
Energy West Inc.	-	750	500 2/	4,000	1,125	4,625
Milner Coal Corp.	-	500	-	500	-	-
Northern Minerals Co.	440 1/2/	-	1,200	-	1,200	-
Peabody Coal Co.	900	600	1,400	600	2/1,400	600
P & M	350 2/	1,100	700 1/	1,500	700	1,800
Rockcastle Co.	-	250	-	250	-	250
Ruby Construction	200	-	200 1/	-	200	-
Sheridan Ent.	150	135	150	135	150	135
Sun Coal Co.	-	200	-	200	200 1/	-
Sunland Coal Co.	100	-	100 1/	-	100	-
Utah Int. Inc.	1,330 2/	1,600	690	2,675	1,290	1,875
W.R. Grace & Co.	-	1,000	1,000 1/	-	1,000	-
Subtotal	10,720	9,535	13,190	14,260	15,215	13,085
Total	20,255		27,450		28,300	

1/ Short-term tracts needed to sustain existing production.
2/ Mine plan approvals other than those needed for short-term lease tract and/or mine modifications.
3/ F = Federal
NF = Non-federal

2. The mid-level includes production from new mines or existing mines on existing federal leases that would need a mine plan approval.

3. The mid-level includes a small amount of production of non-federal coal that would result from development of additional federal coal. Since this amount of non-federal coal is small and would not otherwise be developed, it is included with federal coal under the term "additional federal coal" for the purpose of this analysis.

4. The mid-level also includes potential short-term leases which it is assumed would meet the current short-term standards. The short-term leases would be needed to sustain production and not to increase production. The exact size and location of these short-term tracts cannot be determined but are assumed to be as shown in Map 1-1 (Appendix C).

5. It is assumed, where applicable, that after each short-term lease has expired, another short-term lease would be issued to take its place.

6. For each short-term lease it is assumed that a modified mine plan approval would be necessary.

Production resulting from development of additional federal coal is estimated to be 3,660,000 tons by 1980, 9,255,000 tons by 1985, and 12,430,000 tons by 1990. This includes production from new mines which need mine plan approval and production from short-term lease areas. Table 1-3 shows data projected for all development, private, state, and federal, at mid-level. Table 1-4 shows the acreage requirements for production at mid-level.

This mid-level production schedule is based on personal telephone communications with mine operators, solicited letters of intent, and other investigations. Some companies own more than one mine. Production is presented as an aggregate of all mines, present and projected, surface and underground, which are controlled by an individual company (Table 1-2).

Figure 1-2 is a graph showing the projection for mid-level production in comparison with low-level, and high-level, and NWCCRES production. Map 1-1, Appendix C, shows the lands from which the mid-level production would orginate. Map 1-2 and 1-3, Appendix C, show lands from which low- and high-level production would be derived. These lands include existing federal leases with ongoing mines, potential short-term leases, new mines on existing leases, and known areas of existing future private development. Lease numbers and a more detailed list of existing leases (state and federal) appear on the study area map included in the NWCCRES.

TABLE 1-3

CUMULATIVE DATA PROJECTED FOR THE FEDERAL PORTION OF MID-LEVEL DEVELOPMENT

Activity or facility	1978	1980	1985	1990
Number of new mines	2 1/	4 2/	6 3/	6
Power plant capacity (megawatts)	-	-	760	760
Increased production from additional development of federal coal (1000s of tons)	270	3,660	9,255	12,430
Approximate population increase	-	3,200	11,100	15,300
Miles of new railroad	-	-	12.5	12.5
Miles of new road 4/	-	20	50	75

1/ Pittsburg & Midway underground mine, and Northern Minerals Co.
2/ 1978 mines plus Utah International underground mine, and Ruby Construction Co.
3/ 1980 mines plus Energy West Inc., Peabody Coal Co. (Moffat Mine).
4/ Includes coal exploration trails, access roads, and haulage roads.

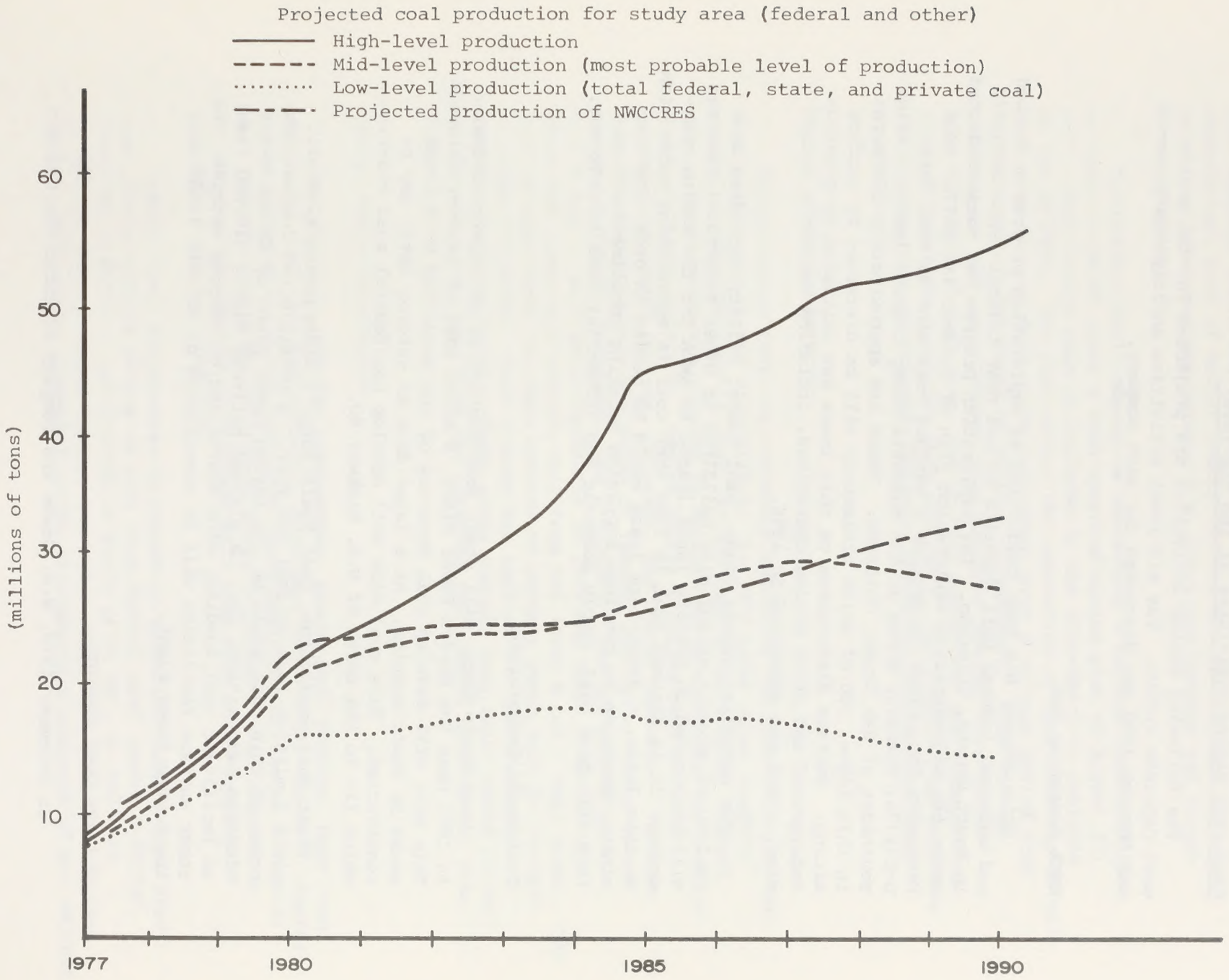
TABLE 1-4

ACREAGE REQUIREMENTS FOR COAL RELATED DEVELOPMENT
ACCOMPANYING DEVELOPMENT OF ADDITIONAL FEDERAL COAL AT MID-LEVEL (ACRES)

	1978-80	1981-85	1986-90	Total
Surface mines	470	2,030	2,500	5,000
Surface mines revegetated	100	470	2,030	2,600
Roads 1/ 2/	420	630	525	1,575
Surface mine facilities and related R/W 1/ 6/	-	100	-	100
Underground mines and related R/W 1/ 3/ 6/	400	200	-	600
Power plants 1/	-	380	-	380
Railroads 1/	-	225	-	225
Population 1/	320	780	430	1,530
Total disturbed 5/	1,610	4,345	3,455	9,410
Total revegetated 4/	100	470	2,030	2,600
Total permanently lost 1/	1,140	2,315	955	4,410

1/ This acreage considered permanently removed from production for the time frame of this report.
2/ Includes haul roads, access roads, and coal exploration trails.
3/ Does not include subsidence.
4/ Includes acreage revegetated from mine and powerline disturbance.
5/ The total disturbed acreage includes all those in footnote 1/ and acres disturbed from surface mines and powerlines.
6/ R/W: Rights-of-way.

Figure 1-2.


Projected coal production for study area (federal and other)
High-level production
Mid-level production (most probable level of production)
Low-level production (total federal, state, and private coal)
Projected production of NWCCRES
(millions of tons)
60
50
40
30
20
10
1977
1980
1985
1990

Projected Mining Activities at the Mid-level

The following mining activities are projected for the northwest Colorado region. The mid-level activities anticipated to occur through 1990 are discussed for each company.

AMCA Resources Inc.

This company has been conducting an exploration program on leased and unleased federal coal deposits on and near federal lease D-051376 in Routt County, Colorado. The exploration program has been conducted under the USGS-approved exploration plan of October 11, 1977. AMCA Resources Inc. plans to develop a surface coal mine on coal lease D-051376, formerly known as the Maneotis Sheep Company lease, 3 miles southwest of Oak Creek, Colorado. There are approximately 250 acres in this lease, 200 of which ultimately will be disturbed by surface mining. Surface disturbance on this lease was initiated by previous underground and strip mining operations, including the Seven Points mine, which was abandoned in 1954.

The necessary access roads, haul roads, utility corridors and rail spurs as well as any mine buildings or other structural features will be located on private lands leased to AMCA for the mining operation. It is assumed that in 1988 when coal is approaching exhaustion on this lease, a short-term lease would be needed in order for the mining operation to continue supplying existing commitments. Coal from this mine will supply domestic and industrial uses in Colorado.

Coal Fuels Corporation

Coal Fuels Corp. will start construction of an underground mine in 1978 near the Hayden Power Plant, 4 miles east of Hayden, Colorado. This mine will develop coal reserves of the Wadge and Wolf Creek seams by shaft entries. At a later date an outcrop entry may be constructed. This coal mine will develop non-federal coal reserves which lie to the north of U.S. Highway 40.

At full production, Coal Fuels Corp.'s underground mine will yield 2 million tons of coal per year. A possible and logical customer of this coal would be the Hayden power plant of Colorado-Ute Electric Association, Inc. A planned railroad siding (10,600 feet) to facilitate coal loading, mine shafts and/or outcrop entries, and other surface facilities will be constructed on private lands near the Hayden Power Plant.

Colowyo Coal Company

In December 1973, W.R. Grace and Company acquired the Colowyo

Coal Company, including federal lease D-034365, in Axial Basin in the southeastern part of Moffat County, Colorado. The Colowyo Coal Company is a joint venture between W.R. Grace and Company and Hannah Mining Company.

The Colowyo Coal Company is conducting a surface mine operation on lease D-034365 under a USGS-approved mining plan of August 17, 1977. This mining plan is included in the site-specific analysis of the NWCCRES. The plan covers the extraction of approximately 85 million tons of coal from eight coal seams over a 30-year period with approximately 1,500 acres of surface disturbance. With initial start-up in 1977, the Colowyo mine produced 294,500 tons in 1977 from the upper X coal seam, and at full production the Colowyo coal mine will produce 3 million tons per year. The Colowyo mine supplies coal to the city of Colorado Springs, Colorado, and various other consumers.

Empire Energy Corporation

Empire Energy Corp. is currently operating two underground mines, Wise Hill 5 and 5A and Wise Hill 9. In 1977 these mines produced a total of 444,200 tons of coal, 77,300 tons of this being federal coal. These mines are located in Moffat County approximately 6 miles south of Craig, Colorado. Empire Energy supplies coal to power plants in Colorado Springs, Colorado, and Omaha, Nebraska. The company has approximately 446 acres of federal coal under three issued leases, D-056298, C-0126480, and C-0127865. Two new mines, Wise Hill 6 and 7, will begin operation in 1978 and 1980, respectively. These two mines will extract coal from the lower E and C coal seams. The face up area where the main entries of portals begin will be located on lease C-0126480. This company has applied for two short-term competitive lease areas. These areas contain coal which would be used to sustain production from the existing and planned underground mines beginning in 1988.

Energy Fuels Corporation

Energy Fuels, and its predecessor, Energy Coal Company, have been producing coal from Routt County, Colorado, since 1962. In 1977, Energy Fuels produced 3,850,600 tons from three strip mines, one on a federal coal lease. The major portion of Energy's production is shipped to Public Service Company of Colorado with some also being shipped to Illinois Light and Power Co.

Energy Fuels Corporation is presently operating under a mine plan that covers surface mining of coal from federal coal leases D-052547, C-081330, C-0128433, and C-12685 in parts of T. 4N., R. 86W. and T. 5N., R. 86W. in Routt County, Colorado. This mine plan was approved in June 1975 and is presented in the site-specific analysis of the NWCCRES.

The approximate locations of short-term lease areas that are needed to maintain production at Energy Fuels mines 1, 2, and 3 are shown on Map 1-1 (Appendix C). It is assumed in the mid-level production projection that part or all of these short-term lease areas will be leased prior to 1981 or 1982, to maintain existing coal production. Portions of these short-term lease areas were analyzed for lease issuance in the NWCCRES.

Energy West Inc.

The development of this company is in conjunction with that of Energy Fuels Corporation.

This company has several planned operations. Future development of most of these operations will involve private or state lands and some federal lands.

The Sugarloaf mine is scheduled to start in 1981 with a maximum production rate of 2 million tons per year over an anticipated mine life of 21 years. This will be a multi-seam surface mine on private coal approximately 15 miles west of Craig and south of U.S. Highway 40. A railroad spur would be constructed from the northeast of the property to the railhead at Craig. No federal rights-of-way would be required for development of the spur.

The Tieken project is located in western Routt County, south of Hayden, Colorado. This property consists principally of private surface and private minerals with a small amount of federally owned coal presently under lease (C-081251) to the Peabody Coal Company. This mine would utilize underground mining methods and has a tentative start-up date of 1983. This mine would attain a maximum production rate of 750,000 tons per year over an anticipated mine life of 21 years.

The McGregor Project is located south of Milner, Colorado. The coal within the subject property is entirely privately owned and will be mined by surface techniques with a maximum annual production rate of 500,000 tons per year over an anticipated mine life of 8 years. This project is anticipated to use the existing tipple and load-out facilities at Energy Fuels Mine 3.

Energy No. 1 underground mine will be near the existing Energy 1 and 2 surface mines in Routt County, Colorado, approximately 20 miles southwest of Steamboat Springs in T. 4N., R. 86W. This mine would begin production at approximately 1 million tons per year and increase to 3 million tons per year. The mine is anticipated to begin in 1985 and would mine both private and federally owned coal for 30-35 years.

Other planned operations include the Energy No. 3 underground mine which will be located near Energy Fuels existing Pit No. 3. This

mine will involve no federal coal or federal surface lands. Production will be 250,000 tons/year with a mine life of 7 years. The anticipated start-up will be 1981. This will be a test mine, to gain experience for the Energy 1 underground mine.

The Mapco operation will be on state lands about 3 miles south of Milner, Colorado. Anticipated start-up date for this mine is 1979 and it will produce 500,000 tons per year for 6 years.

Only the Energy 1 underground mine and the Tiekien project would require federal mine plan approvals. These mines would be located on existing federal leases and private lands.

Coal from the above projects will most likely be sent to Public Service Company of Colorado or Illinois Light and Power Company.

Milner Coal Corporation

This firm began surface mining operations in 1975 on private land located southwest of Milner, Colorado. Production in 1975 totaled 28,500 tons with no production for 1977. This company has plans to resume surface mining operations in 1979 with an approximate production of 500,000 tons per year for about 10 years. The market for this coal is not presently known.

Northern Minerals Company

Northern Minerals Company, a subsidiary of Northern Natural Gas Company of Omaha, Nebraska, has purchased federal coal leases C-076713 and D-044240 from Sewanee Mining Company, Inc., and is currently producing coal for local consumption from these leases. This mine is located approximately 5 miles north of Meeker, Colorado, on State Highway 13/789. Northern Minerals Company has conducted an extensive drilling program on lease C-076713, and plans to do further drilling on adjacent private lands under lease. From the data obtained from the drilling program, the company submitted a mining plan to the USGS on November 1, 1977. This plan calls for the continued mining of the Rienau (G) seam for 3 more years by room and pillar methods (120,000 tons per year), to bridge production to that of the planned new mine in the uppermost P seam. This mine would begin in 1979 and would reach a maximum annual production of 657,000 tons per year into 1987. When P seam coal is approaching exhaustion, the lower J seam would be mined beginning in 1984 and reach a maximum production of 826,000 tons per year into 1995. The P, J, and part of the G seam would be mined by longwall methods. It is assumed that in order for this company to use longwall methods for coal mining, portions of an adjacent competitive lease application would have to be issued as a short-term lease. This would permit the maximum economic recovery (MER) possible by longwall mining methods combined with adequate longwall panel length to justify the use of longwall equipment. New surface facilities would be constructed at

the mine site, with buildings such as the office, warehouse, and equipment shops located on private lands of the Rienau Ranch owned by Northern Minerals Company. Coal would be hauled by truck 44 miles to Craig until a railroad spur could be built closer to the mine.

Peabody Coal Company

Seneca Coal Ltd., a joint venture between Peabody Coal Company and Western Utility Coal Company, with Peabody designated as operator, has been producing coal near Hayden, Colorado, since 1964 to supply coal to the Hayden Power Plant. In 1977, Peabody produced 1,291,000 tons of non-federal coal, at the Seneca 2 strip mine. Production increased over that of 1975 (710,313 tons) to supply coal to Unit 2 of the Hayden Power Plant, which began commercial operation in September 1976. The Seneca 2 mine will supply all coal to the plant until the Seneca 2-W operation begins production.

A revised mining plan received approval of the Secretary of the Interior on September 14, 1977, covering stripping operations on federal coal leases C-081251 and C-081258 of the Seneca 2-W mine. This plan is discussed in the site-specific analysis in the NWCCRES. These two contiguous leases, designated as the Seneca 2-W area, are located 4 miles southwest of the company's existing Sencca 2 mine and 4 miles south of Hayden. It is the company's intention to begin production from the 2-W area in 1980 at a rate of 900,000 tons/year for approximately 15 years. The planned Yoast mining area on lease C-0114093, which is east of the Seneca 2-W mine, is anticipated to extend development from 1995 to 2002, which is beyond the time frame of this report.

The Peabody Coal Company also plans to open the Moffat mine, a surface mine, located about 11 miles northeast of Craig, Colorado, in T. 8N., R. 89W. on coal lease C-0125957. Mine construction is scheduled to begin in the early 1980s, with full projected annual production of 500,000 tons per year reached prior to 1986. This mine plan would require federal approval by the appropriate agencies. Approximately 12.5 miles of railroad would be built to connect with the main line of Denver and Rio Grande Western Railroad near Craig, Colorado. This railroad spur would be built entirely on private lands. Other surface facilities such as mine offices, a warehouse, and equipment shops would be constructed on private lands.

Pittsburg-Midway Coal Mining Company (P&M)

This company, a wholly-owned subsidiary of Gulf Oil Corporation, currently operates the Edna surface coal mine on federal, state, and private lands just north of Oak Creek, Colorado. The Edna mine produced 1,094,300 tons of coal in 1977 and will produce approximately 1.0 million tons through 1990 from private lands and existing federal leases. These existing leases (D-033327, C-021601, D-053710, and D-041478) are included in P&M's currently approved mine plan. Coal from the Edna mine is sold to Colorado users.

P&M has plans for an underground mine starting on fee coal in 1978. This mine would eventually move onto part of federal lease C-021601 and would have a maximum production of 600,000 tons per year by 1980 or 1981. It is assumed for the purposes of this report that this mine would require a mine plan approval by 1980. It is also assumed that by about 1985 a short-term lease would be required to maintain production at this underground mining operation. In June 1977, the Edna prototype underground mine was opened on Wadge seam fee coal. The purpose of the prototype mine was to test conditions that could be expected to occur during the underground mining of the Wadge seam on lease C-021601 and other potential lands to the north and west. This test mine produced 13,100 tons in 1977.

The P&M Mining Company will also have new surface and underground mines on state lands by 1984, with a production of 100,000 and 300,000 tons per year, respectively. This coal will also be sold to Colorado users.

Rockcastle Company

The Rockcastle Company plans to open a surface mine on 740 acres of state land located 7 miles southeast of the Hayden Power Plant by 1980. This mine will produce a maximum of 250,000 tons of coal per year with a mine life of about 8-10 years. Coal would be hauled from the mine on County Road 27 to U.S. Highway 40, and then to the Mt. Harris railroad siding. Approximately 30 percent of this coal will be used domestically. The market for the remainder of this coal is not known.

Ruby Construction Company

On December 18, 1974, Ruby Construction Company submitted a mining and reclamation plan for its Sun mine covering proposed underground coal production from its federal coal lease, D-051698. The company proposed to produce 200,000-300,000 tons per year to supply the local domestic market and other users. This mine plan was discussed in a site-specific analysis in the NWCCRES but as of September 1978, the plan is still pending approval of the Secretary of the Interior. After mining begins the estimated reserves show that a production of 250,000 tons per year could be sustained for approximately 5 years, after which it is assumed that a short-term lease would be required.

Sheridan Enterprises Inc.

Sheridan Enterprises Inc. plans on starting an underground operation in 1978 on federal lease D-052546, which consists of approximately 160 acres. This mine will be located 4 miles northwest of Oak Creek, Colorado, just west of P&M's Edna Mine. This mine will produce approximately 150,000 tons of coal per year for 12 years which will be sold in a local market. The Joe's mine, an abandoned mine, has pro-

duced coal from this lease for which a mine plan still exists. Coal will be trucked to rail approximately 4 miles from the mine site. Sheridan Enterprises Inc. also plans for a mine on state lands at Butcher Creek Gulch approximately 6 miles northwest of Milner, Colorado. Exploration will be conducted in 1978, but an exact start-up date has not been determined. The mine is anticipated to produce 135,000 tons per year at full production.

Sun Coal Company

Sun Coal is a subsidiary of A.T. Massey Coal Company. This company operates the Meadows No. 1 surface mine, which is on private lands approximately 16 miles west of Steamboat Springs near U.S. Highway 40. In 1977, the year of initial production, this mine produced 62,912 tons of coal. This mine has a projected life of approximately 10 years, after which it is assumed that a federal short-term lease would be necessary for continued production. Sun Coal also has tentative plans for an underground mine in the vicinity of existing operations. The market for the Sun Coal Company's coal is not presently known.

Sunland Coal Company

Sunland Coal Company purchased the Apex underground mine on federal coal lease D-046544 from the Routt Mining Corporation. This mine is 5 miles northwest of Oak Creek in Routt County. The operation produced 11,900 tons in 1977 but is scheduled to reach a maximum production of 100,000 tons per year. An underground mine plan for lease D-046544 and C-0127592, which adjoins D-046544, was submitted to the USGS to show methods of recovering remaining coal reserves within the two existing leases. This plan, submitted to meet 30 CFR 211 Coal Mining Operating Regulations, was given approval by the Secretary of the Interior on February 3, 1978. It is assumed for the purpose of this report that a short-term lease would be needed to sustain existing production from the Apex mine. Coal from this mine is supplied to a local market.

Utah International

Utah International operates the Trapper coal mine, a surface mine, located just south of Craig, Colorado in the Williams Fork Mountains. The Trapper mine plan for leases C-07518, C-07519, and C-079641 received approval by the Secretary of the Interior on October 18, 1977. This mine plan was included in the Yampa Project environmental statement (USDA ES-74-2-F). In 1977, the year of initial production, this mine produced 345,900 tons of coal from non-federal lands. Coal from the Trapper Mine is presently being stockpiled for use in the Craig Power Plant. Utah International has a contract to supply 2.4 million tons per year to Colorado-Ute Electric Association for electrical generation in the Craig Power Plant. This company also has plans to open an underground mine in 1979, with mine portals located further south of existing strip mine

operations to gain access to coals lower in the stratigraphic sequence than those of the present surface operations. This coal will also be supplied to the Craig Power Plant.

W.R. Grace and Company and Hanna Mining Company

This company is planning to start its Hayden Gulch project on private lands in 1978. The Hayden Gulch mine will be located in Routt County, Colorado, approximately 10 miles south of Hayden. This mine will produce between 750,000 and 1 million tons per year from private lands by surface mining methods. Mining would continue on private lands through 1986, but would only continue after that date if federal coal to the northwest could be leased under current short-term standards. Surface facilities would also be located on private lands. Coal would be trucked approximately 8 miles to a loadout facility on a rail spur located 2 miles southeast of Hayden, Colorado. Coal would be transported to Texas for use by the Cellanese Corporation.

Coal-Related Development

Coal-Fired Power Plant Developments

Existing power plants in the study area include the 450 megawatt Hayden Power Plant and the almost completed Units 1 and 2 of the Craig Power Plant with a combined capacity of 760 megawatts. Both plants are operated by Colorado-Ute Electric Association and power from them is fed into a regional power network. A planned third generation unit for the Craig Power Plant is included in the mid-level scenario and is assumed to have a generating capacity of 380 megawatts.

Coal for the plants would be produced in the study area. The Hayden Power Plant, in 1977, used 1,291,000 tons of coal. Operating at peak capacity year-round, it would require approximately 1,971,000 tons of coal per year. The first two units of the Craig Power Plant, if operating at peak capacity, would require 3,329,000 tons of coal per year. Peak capacity of all three generation units, when on line, would require 4,993,500 tons of coal per year. Full capacity of both plants, in the mid-level scenario, would consume 6.96 million tons annually.

Powerline Construction

Powerlines include an 88-mile line from Craig to Rifle. This powerline is under construction by the Colorado-Ute Electric Association Inc. and will connect to the Craig Power Plant. Another powerline was initiated in November of 1977 to supply power to the C-b oil shale tract. This powerline will be 25 miles long stretching from Meeker to the C-b tract. This line will be

constructed by the White River Electric Co. No additional powerlines would be needed at mid-level.

Transportation Developments

Approximately 80 percent of the annual coal production would be hauled by unit trains over existing Denver and Rio Grand Western (D&RGW) railroad lines from Craig to eastern Colorado and beyond. As shown in Table 1-5, there would be 27 miles of new railroad attributable to mid-level development by 1980 and an additional 28 miles by 1985, after which there would be no increase. Truck haulage would still play an important role in hauling coal from mine site to rail spur. For this purpose there would be 30 miles of new road at mid-level by 1980, 80 miles by 1985, and 130 miles by 1990.

Regarding additional railroad construction necessary for coal development in northwest Colorado, only the planned rail spur from Peabody's Moffat mine to Craig will be included at mid-level. This 12.5-mile rail spur would be necessary to develop federal coal on the planned mine site and therefore is a result of a mine plan approval that would be a future federal action. A description of other railroad construction, which will be summarized as part of the whole regional development, follows. Approximately 15 miles of rail spur will be constructed from Energy West Inc.'s Sugarloaf mine to the rail head in Craig. W.R. Grace and Company will construct approximately 2 miles of rail spur and rail loop for transportation to market from the Hayden Gulch mine near Hayden. A planned 10,600 feet (2 miles) of railroad siding is to be constructed for the Coal Fuels Corp.'s planned underground mine near the Hayden Power Plant. The Colowyo railroad spur, which was discussed in the site-specific analysis in the NWCCRES, has since been approved and construction is proceeding. This railroad consists of approximately 25 miles of track between Craig, Colorado, and Axial Basin.

Non Coal-Related Development

Oil and Gas

Oil and gas exploration is expected to continue at a high level, and future prospecting should result in discovery of more oil and gas fields and producing zones. Oil and gas operations in northwest Colorado are anticipated to continue for at least another 40 years.

Oil and gas operations can at times conflict with potential coal mining operations. In northwest Colorado, oil or gas deposits may occur below, on the same horizon, or above the commercial coal bed of the Mesa Verde Group. In general, simultaneous operation of a coal mine and a producing oil or gas field are potentially difficult. Drill holes may interfere with underground operations where the holes intersect the coal bed. In addition, wells

drilled through coal seams may be sheared, allowing hydrocarbon vapors to penetrate the coal seam, creating a safety problem which could preclude further mining in the affected areas.

Resolution of these resource conflicts must be settled on a case-by-case basis. Often it becomes necessary to extract one resource prior to extracting the other. However, even sequential extraction of the two resources can create potential problems for the second resource extractor.

Drilling for oil and gas resources in an area of abandoned underground mine workings may be difficult due to loss of drilling media and circulation if the abandoned workings are encountered. Maps of abandoned underground mines would have to be obtained and thoroughly studied to prevent inadvertent drilling into the underground workings.

In the reverse case, where a mining operation is to follow extraction of petroleum products, the location of oil and gas wells would have to be determined by the mining company in order to leave safety pillars around the wells (refer to 30 CFR 211.11 for further discussion). Generally in cases requiring sequential extraction, it is more prudent for technological reasons to extract the coal resources before the oil and gas resource.

Methods do exist for mitigating the conflicts of simultaneous development. Oil and gas wells can be confined to "islands" on the surface where their effect on the coal reserves can be minimized. Then by means of off-set or directional drilling, the petroleum reserves can be tapped while allowing continued orderly operation of a coal mine. The additional cost of this type of drilling is usually very small in comparison with the potential loss of coal reserves.

Conflicts between oil and gas leasing and potential coal leasing exist within the study area, specifically in southeast Moffat and southwest Routt Counties, Rio Blanco County northeast of Meeker, and the area generally north of Rangely, Colorado. Where conflicts do occur, resolution will follow procedures outlined in BLM Instruction Memo 78-15. According to this memo, areas where there are existing coal leases, preference right lease applications for coal, competitive coal lease applications which meet short-term standards, or areas which are considered as a result of the BLM planning process to have better potential for coal than for oil and gas development will be leased exclusively for coal. Areas where land is classified by the USGS as being within a Known Geological Structure (KGS) (an area identified as containing oil and gas) will be considered as having greater potential for oil and gas than for coal and will accordingly be leased exclusively for oil and gas. Where potential cannot be determined definitely in favor of either, recommendations for either coal or oil and gas or for simultaneous leasing will be made through the BLM planning system and the final determination made by the Colorado State Office of BLM.

Oil Shale

No proposals are on record for development of oil shale in the area of this report. Oil shale does occur in large areas of northwest Colorado but is of low quality in the study area and, therefore, does not have great potential for development. Most of the high-grade oil shale resources in Colorado are located just south of the study area, in the Piceance Creek Basin of Rio Blanco County.

Two federal prototype oil shale lease tracts, C-a and C-b, lie within the Piceance Creek Basin. In September 1977, the detailed development plans submitted by the leaseholders of both tracts were approved by the Department of the Interior. Both of the approved plans are for modified in-situ oil shale recovery facilities.

Two oil shale tracts (Ua and Ub) located in northeastern Utah are near the western boundary of the study area. These tracts are scheduled to be developed as a single operation. At the present time, they have been indefinitely enjoined from operation by a court order, issued because of existing mining claims for minerals and also because of the selection of lands in the tracts for state school lands by the State of Utah.

The Superior Oil Shale Project, located at the mouth of the Piceance Basin, is expected to begin operations in 1980. This will be a private development.

Uranium

No formal proposals to mine uranium in northwest Colorado are known at present. Exploration activities continue intermittently in the western and northern parts of the region. Uranium is being extracted by leaching of previously mined material near Maybell, southcentral Moffat County, Colorado. On the basis of existing market conditions, the potential for future uranium mining in northwestern Colorado is good.

Geothermal Resources

Geothermal resources in the study area have not been and probably will not be developed to a significant degree in the near future.

Water Reclamation Projects

Several reservoirs have been proposed which would require water from the Yampa and White River systems. The projects being pursued most actively at the present time are Yamcola, Juniper-Cross Mountain, and Savory-Pot Hook in the Yampa River basin and Rangely Reservoir in

the White River Basin. None of the projects have been initiated. A complete listing can be found on pages I-24 and I-25 in the Regional Analysis of the NWCCRES.

Recreation Designations

Currently no designated Wild and Scenic rivers occur in the study area. Designated wilderness areas that occur in the study area are within National Forest lands which would not be affected by additional coal development.

Section 603 of the Federal Land Policy and Management Act (FLPMA) requires that the Craig District of BLM inventory all public lands within the region for wilderness potential. Tracts having an area of 5,000 acres or more and possessing both roadless and wilderness characteristics will become wilderness study areas. This wilderness review procedure must be completed by October 21, 1991.

Projected Aggregate Coal Development

Coal production in the northwest Colorado region in 1977 was 7.4 million tons. The mid-level production, to be analyzed in this report, is estimated to be 20.3 million tons per year by 1980, 27.5 million tons per year by 1985, and 28.3 million tons in 1990. This development differs slightly from that projected in the NWCCRES; it is 15 percent less in 1980, 9 percent greater in 1985, and 14 percent less by 1990, as shown in Figure 1-2. This difference is primarily due to PRLAs, which were included in the NWCCRES production projections but are only included in the high-level scenario of this report.

The following narrative is based on projected coal and ancillary developments for all sources of coal - private, state, and federal - in the study area. It establishes parameters and guidelines for analysis of regional impacts. For the impacts resulting from that proportion due only to possible development of additional new federal coal, refer to previous Tables 1-3 and 1-4.

The data contained in Table 1-5 are parameters for analysis of the mid-level portion of this report. As with the production projections, this information is based on interviews with local representatives of companies, on letters of intent, and on BLM's estimate of necessary facilities required for the increased production from new federal coal.

Coal-Related Requirements

It is assumed, in this report, that a total of 12.5 miles of new railroad would be constructed by 1985 as a result of additional development of

federal coal. This would be 46 percent of the total new rail construction anticipated to be completed between now and 1985 in the study area. It is further anticipated that development of additional federal coal would generate 29,280 carloads of coal annually by 1980, 74,040 carloads by 1985, and 99,440 carloads by 1990, assuming a 100-ton net hopper car (263,000 pounds gross limit and 80 percent of coal production being hauled by rail). This would be, respectively, 18 percent, 34 percent, and 44 percent of the total number of carloads of freight generated by the region. Issuance of short-term tracts would not increase the level of rai operations since these tracts would be used to maintain the levels of production at existing operations.

Table 1-5 shows the expected population increase that would occur at mid-level production (note that this population increase is not only due to new employees, but increased population for the study area). As indicated, the population would increase over current levels by 4,000 by 1980, by 22,700 by 1985, and by 28,500 by 1990. Figure 1-3 shows the employment projections for low-level, mid-level, and high-level.

Other coal-related developments are shown in Table 1-5 and include railroads, power plants, underground mines with necessary facilities and rights-of-way, surface mine facilities and rights-of-way, powerlines and roads.

Projected Acreage Requirements

Tables 1-6 and 1-7 list the expected increase in acreage required by mining and associated facilities through 1990. Figure 1-4 shows the acres of disturbance from direct mining and the total acres of disturbance for low-, mid-, and high-levels through 1990. Total acres disturbed in the mid-level scenario for 1978-80, 1981-85, and 1986-90 are 7,900 acres, 11,810 acres, and 9,060 acres, respectively, yielding an overall total of 28,770 acres disturbed. Of these acres disturbed, a total of 8,970 acres would be permanently disturbed by 1990.

Projected Water Requirements

The two primary uses of water that would increase through 1990 are urban use and mine use, which includes coal handling. Table 1-7 lists projected water requirements for urban and mine use of the study area through 1990 based on water requirements for development listed in Table 1-9. Water requirements for power plants included in the mid-level scenario will be 18,150 acre-feet per year by 1980, 23,850 acre-feet per year by 1985, and remaining at 23,850 acre-feet per year thereafter.

Analysis Assumptions and Guidelines

The following guidelines and assumptions were used in analysis of regional impacts.

TABLE 1-5

CUMULATIVE INCREASES OVER 1977 LEVELS PROJECTED FOR DEVELOPMENT AT MID-LEVEL IN THE STUDY AREA

Projected increases (state, private, & federal)	1977	1980	1985	1990
Coal mines	12	26	33	33
Power plant capacity (megawatts)	450	450	830	830
Tons of coal mined (1000s of tons)	7,404	20,255	27,450	28,300
Approximate population	25,929	29,900	48,600	54,400
Miles of railroad	-	27	55	55
Miles of new road	-	30	80	130

Figure 1-3.

Employment Projections

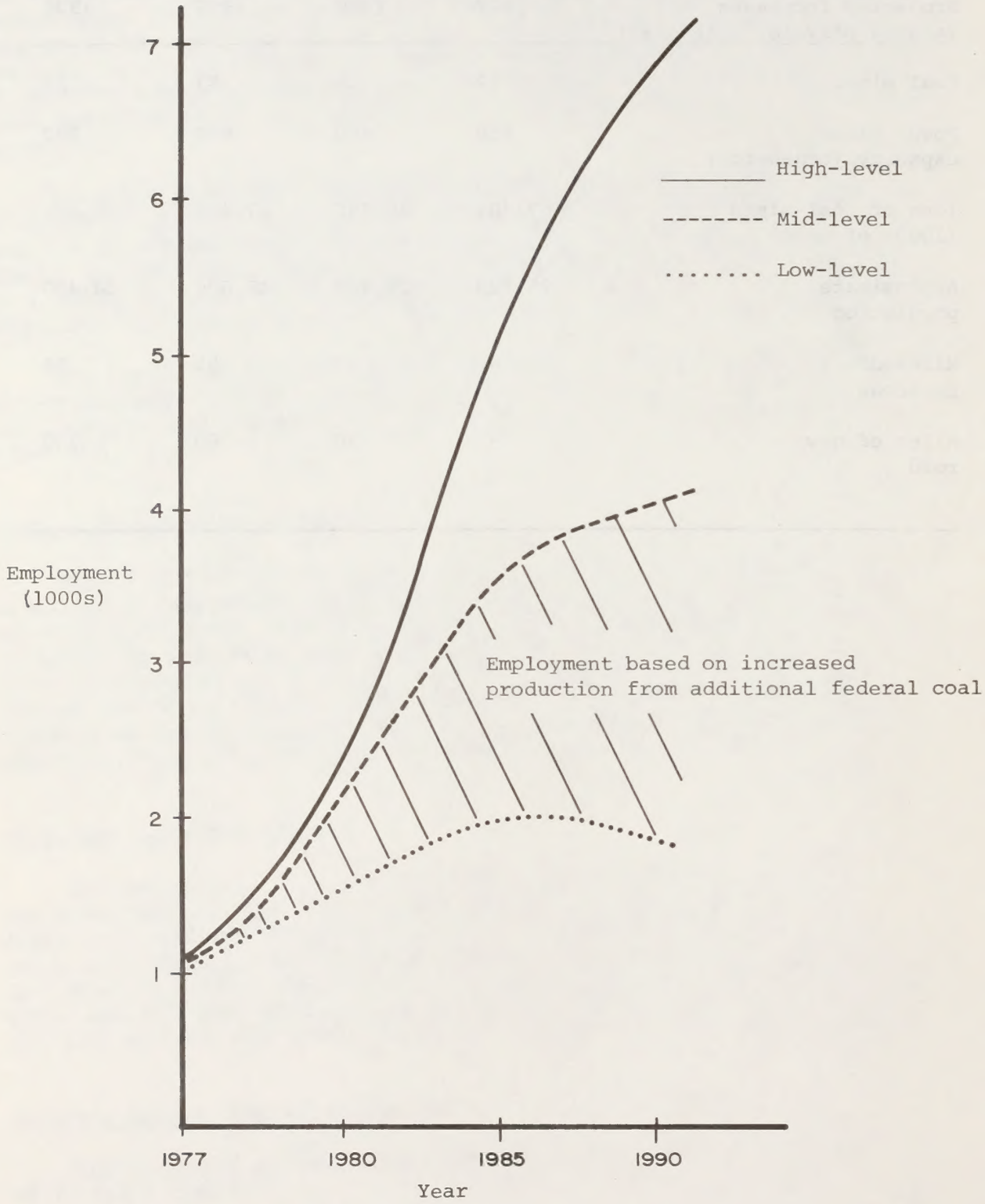


TABLE 1-6

ACRES DISTURBED AND REVEGETATED
(FOR MID-LEVEL SCENARIO) (IN ACRES)

	1978-80	1981-85	1986-90	Total
Surface mine area disturbed	3,280	7,310	7,330	17,920
Surface mine area reclaimed	200	3,280	7,310	10,790
Disturbance due to powerlines	1,880	-	-	1,880
Revegetated powerline areas	-	1,880	-	1,880
Roads 1/ 2/	630	1,050	1,050	2,730
Surface mine facilities and related R/W 1/ 6/	700	300	0	1,000
Underground mines and related R/W 1/ 3/ 6/	520	400	0	920
Power plants 1/	-	380	-	380
Railroads 1/	490	500	100	1,090
Population 1/	400	1,870	580	2,850
Total disturbed 5/	7,900	11,810	9,060	28,770
Total revegetated 4/	200	5,160	7,310	12,670
Total permanently removed	2,740	4,500	1,730	8,970

1/ This acreage considered permanently removed from production for the time frame of this report.
2/ Includes haul roads, access roads, and coal exploration trails.
3/ Does not include subsidence.
4/ Includes acreage revegetated from mine and powerline disturbance.
5/ The total disturbed acreage includes all those in footnote 1/ and acres disturbed from surface mines and powerlines.
6/ R/W = Rights-of-way.

TABLE 1-7

PRODUCTION, DISTURBANCE, AND RECLAMATION AT MID-LEVEL IN THE STUDY AREA 1/

Activity	Projected coal production (1000s of tons)			Total acres of disturbance 2/				Total acres revegetated			
	1980	1985	1990	1978-80	1981-85	1986-90	Total	1978-80	1981-85	1986-90	Total
Activity on state & private coal lands and activity of ongoing or approved mines on federal leases	16,595	18,195	15,870	6,290	7,455	5,615	19,360	100	4,690	5,280	10,070
Increased activity from additional federal coal (Table 4)	3,660	9,255	12,430	1,610	4,345	3,455	9,410	100	470	2,030	2,600
Totals for mid-level	20,255	27,450	28,300	7,900	11,810	9,060	28,770	200	5,160	7,130	12,670

1/ Data listed for years 1980, 1985, and 1990 are for those specific years. Data listed for time periods 1978-80, 1981-85, and 1986-90 are cumulative for the indicated periods.

2/ Average acreage per year disturbed per million tons of coal mined equals 100 acres. This figure is for coal mines on the Wadge coal seam; mines with thicker seams or multiple seams will create less acreage disturbance per million tons of coal mined.

TABLE 1-7 (Cont.)

PRODUCTION, DISTURBANCE, AND RECLAMATION AT MID-LEVEL IN THE STUDY AREA 1/

Activity	Permanent employment			Unit trains per 3/ year			Annual water requirements for mine and coal handling (acre-ft/year)			Annual water requirements for population increase (urban) (acre-ft/year)		
	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990
Activity on state & private coal lands and activity of ongoing or approved mines on federal leases	1,565	2,200	2,110	1,660	1,820	1,590	510	550	490	130	1,950	2,220
Increased activity from additional federal coal (Table 4)	695	1,540	2,090	370	930	1,240	110	280	380	540	1,870	2,570
Totals for mid-level	2,260	3,740	4,200	2,030	2,750	2,830	620	830	870	670	3,820	4,790

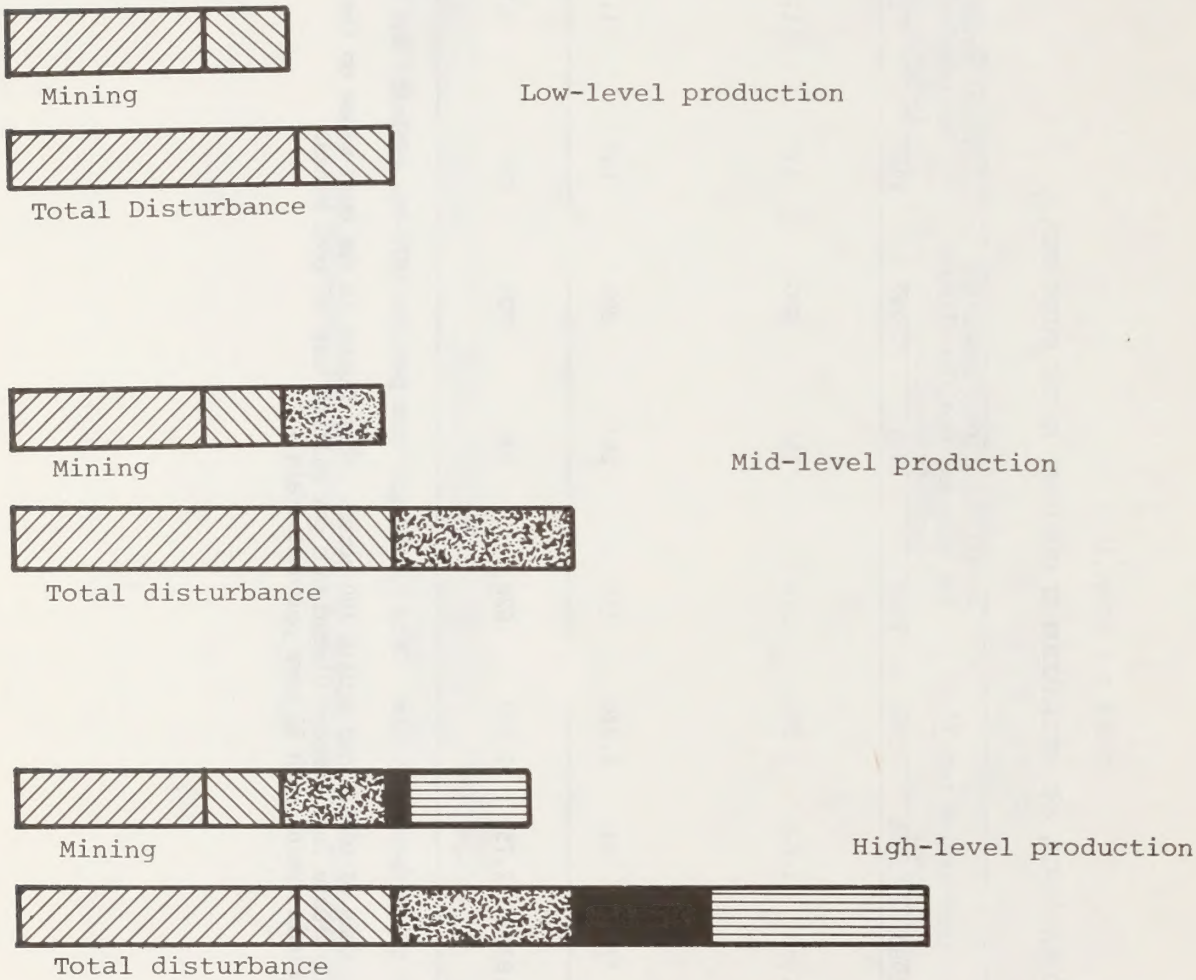
1/ Data listed for years 1980, 85, and 90 are for those specific years. Data listed for time periods 1978-80, 1981-85, and 1986-90 are cumulative for the indicated periods.

2/ Average acreage per year disturbed per million tons of coal mined equals 100 acres. This figure is for coal mines on the Wadge coal seam. Mines with thicker seams or multiple seams will create less acreage disturbance per million tons of coal mined.

3/ Assume 100 ton capacity cars for all cars in a unit train, with 80 cars per unit train.

Figure 1-4.

Acres of Disturbance for Direct Mining and Total Acres of Disturbance to 1990 (For Low-, Mid-, and High-level).



1. Cumulative impacts will be analyzed for three time points (1980, 1985, and 1990).

2. Reclamation schedules will vary for each mining proposal. Normally reclamation would be conducted as an ongoing program. After a surface mining operation has been in progress for 2 to 3 years, the reclamation plan should be revegetating approximately the same acreage as the mining is disturbing annually. The following revegetation schedule is used as a guide to proper restoration of livestock grazing land use:

   First year - reshaping
   Second year - topsoiling and seeding
   Third year - rest for seeding establishment
   Fourth year - rest for plant vigor
   Fifth - allow grazing with controlled management.

3. Mine plan analysis includes all associated facilities required to fully develop the plan (i.e., powerlines, roads, railroads, power plants, and land needed to accomodate increased population). Any impacts lasting over 30 years are considered permanent.

4. The level of mining technology will not change significantly through 1990.

5. Some state, private, and federal coal will be developed in northwest Colorado regardless of future federal actions, (see low-level production, Table 8-1, Chapter 8).

6. Accelerated development of other energy minerals will occur concurrently with coal development in northwest Colorado; this will include oil shale as projected in the Final Environmental Impact Statement for the Prototype Oil Shale Leasing Program, August 1973.

7. As required by both the Federal Coal Leasing Amendments Act (FCLAA) and the revised leasing regulations, coal leasing will take place only in areas where a comprehensive land use plan has been prepared and where such leasing is compatible with this plan. To meet this requirement within the study region, all coal development areas will be addressed by BLM in its Management Framework Plans (MFPs) described under Land Use Plans, Controls, and Constraints, Chapter 3, of this report.

8. Short-term leases that would be needed to sustain the mid-level production projection would be issued under current short-term standards. It is assumed that when these leases have expired another short-term lease will be issued to sustain production and not increase production. A modified mine plan will be required.

9. The demand for coal will remain at a level that will continue to encourage development of Colorado coal.

10. Additional assumptions regarding acreage and water requirements for various elements of projected coal-related development area presented in Tables 1-8 and 1-9.

TABLE 1-8

ACREAGE REQUIREMENTS FOR DEVELOPMENT

Facility	Acres required
Water-cooled power plant	1 per megawatt
Mine-buildings, shops	100 per mine
Powerline (230-kV)	18 per mile
Powerline (138 and 69-kV)	12 per mile
Roads (175' right-of-way)	21 per mile
Per 1,000 population increase	100
Railroads (150' right-of-way)	18 per mile
Per million tons of coal mined	100

TABLE 1-9

WATER REQUIREMENTS FOR DEVELOPMENT

Facility	
Power plant (water cooled)	15 acre-feet per year per megawatt
Population increase (urban)	150 gallons/day/person 1/
Per ton of coal produced	10 gallons

1/ 50 gal/day would be consumed and 100 gal/day would be returned to streams as sewage.

CHAPTER 2

DESCRIPTION OF THE ENVIRONMENT

PRESENT ENVIRONMENT

The following chapter describes the physical, biological, and cultural resource values which consititue the environment within the study region. This description focuses on environmental details most likely to be affected by possible future development of federal coal.

This chapter essentially summarizes detail which has already been covered in the NWCCRES, but it also includes updated information gathered by specialists of the environmental report team.

Topography

The coal-bearing region of Moffat, Routt, and northern Rio Blanco counties is characterized by broad open plains with low relief ranging in altitude from about 5,200 to 7,700 feet. Drainage is westward by the White and Yampa Rivers. A more complete description can be found in the Regional Analysis of the Northwest Colorado Coal Regional Environmental Statement (NWCCRES).

Stratigraphy

There are approximately 50 named stratigraphic formations or groups in the study area, ranging in age from Precambrian to Recent. Two maps by Tweto (1975a, b) have been used for this study and are found in Appendix A of the NWCCRES. For a discussion of the non-coal-bearing rocks and for more detail concerning the coal-bearing sequence, see Stratigraphy in Chapter II, Regional Analysis, NWCCRES.

Coal beds of economic interest are present only in strata of the Iles and Williams Fork Formations of Late Cretaceous age and the Fort Union Formation of Tertiary age. These formations were deposited mostly in terrestrial environments consisting of sandstones, siltstones, and sandy shales. This environment also included swamps where organic material accumulated, ultimately to be changed into coal beds.

Structure

Structurally, northwest Colorado is characterized by a complex series of anticlines and synclines with many subsidiary folds and faults. These features are best shown on foldout Map 4, Appendix A, NWCCRES. As shown on these maps, the most important coal-bearing formations commonly occupy the flanks of anticlines and synclines.

Geomorphology

Most of the region under study is underlain by moderately resistant strata of late Mesozoic and Tertiary Age modified by differential erosion. The resulting surface is characterized by locally steep scarp slopes and moderately steep dip slopes. Landslides and slumps typically occur on steep slopes, particularly where the slopes are underlain by soft rocks.

A characteristic feature of northwest Colorado is superimposed streams that disect ridges, hills, and other structural features. An example would be the meanders that are entrenched along the Yampa downstream from Craig.

Paleontology

Fossils are found in most of the sedimentary rocks in the study area, ranging from brachiopods and trilobites of Paleozoic age to horse and camel bones of Tertiary Age.

The coal-bearing strata in the study area contain plant leaf impressions in the coals and possible vertebrate remains in the non-marine strata. The marine late Mesozoic deposits may contain ammonites, useful as guide fossils, and Inoceramus clams. A more complete Paleontological description is presented in the Regional Analysis of the NWCCRES (Figure RII-2).

Coal

The three coal fields of the study area, Yampa, Danforth Hills, and Lower White River, are described by Landis (1959) and Speltz (1976) as part of the Green River Region. The Yampa field occurs at the extreme southeast edge of the Washakie Basin. Most of this coalfield is Mesaverde (Late Cretaceous) in age and is described as noncoking, high-volatile C bituminous. Tables 2-1 and 2-2 show the range of analyses for Routt and Moffat Counties Mesaverde coals. The Yampa coalfield contains a Tertiary sub-region north of Craig, as shown in Figure RII-3, Regional Analysis, NWCCRES. U.S. Geological Survey Bulletins 415 and 1027 report that the Tertiary Fort Union contains commercial thickness of coal throughout and is mostly subbituminous (Table 2-3).

Tables 2-4, 2-5, and 2-6 present chemical analyses postdating the NWCCRES for coal from the Yampa coal field. The statistics for these tables come from analysis of 17 coal beds, all of which are from the Late Cretaceous coal-bearing sequence (Boreck et al. 1977).

The Danforth Hills field lies between the White and Yampa Rivers. Coal beds of the field occur in the Williams Fork and Iles Formations of the Mesaverde Group (Figure RII-4, NWCCRES). Local geology is extremely complex, with dips ranging from near-vertical in the western part of the field to near-horizontal in the east and north. The coal is described as noncoking, high-volatile C bituminous.

The Lower White River coal field lies at the extreme northwest part of the Colorado portion of the Uintah Basin and is located between the Danforth Hills coalfield and the Utah border (Figure RII-6, NWCCRES). The coal in this field is high-volatile C bituminous and noncoking with a range of analysis found in Table 2-7.

Speltz (1976) has estimated the strippable coal resources of these fields and as recent as his figures are, they are too conservative, as indicated on page II-9, Regional Analysis, NWCCRES. More recent and accurate coal resource figures are not available.

Other Minerals

Other economic mineral deposits such as oil and gas, oil shale, bituminous sandstone, uranium, zeolites, placer deposits of gold and monazite, and lode deposits of metals are found in the study area. These minerals are discussed in the Regional Analysis of the NWCCRES, and their occurrences are shown on map foldout 5, Appendix B, NWCCRES.

TABLE 2-1

A RANGE OF ANALYSES FOR ROUTT COUNTY MESAVERDE COALS

	As received - 1,537 samples		
	High	Low	Mean
Moisture (%)	18.3	5.6	9.4
Volatile matter (%)	45.9	36.0	41.1
Fixed carbon (%)	58.2	46.8	51.8
Ash (%)	16.5	2.6	6.9
Sulfur (%)	2.8	0.2	0.9
Btu/lb.	12,560	9,550	11,580

TABLE 2-2

A RANGE OF ANALYSES FOR MOFFAT COUNTY MESAVERDE COALS

	As received - 65 samples		
	High	Low	Mean
Moisture (%)	23.3	8.5	11.6
Volatile matter (%)	49.7	37.4	42.0
Fixed carbon (%)	56.3	47.2	53.8
Ash (%)	9.4	2.7	4.3
Sulfur (%)	1.0	0.2	0.3
Btu/lb	12,120	8,860	11,500

TABLE 2-3

ANALYSIS OF TERTIARY FORT UNION COAL

Contents	Sample A 1/		Sample B 2/	
	As received	Dry	As received	Dry
Moisture (%)	18.5	14.2	17.08	12.47
Volatile matter (%)	32.2	33.9	35.30	29.92
Fixed Carbon (%)	44.5	46.7	41.97	50.02
Ash (%)	5.1	5.3	5.65	7.59
Sulfur (%)	0.3	0.3	0.46	1.21
Btu/lb	9,842	10,360	9,330	10,290

1/ U.S. Geological Survey Bulletin 1027, p. 208.
2/ U.S. Geological Survey Bulletin 415, p. 248.

TABLE 2-4

ARITHMETIC MEAN, OBSERVED RANGE, AND GEOMETRIC MEAN AND DEVIATION OF PROXIMATE, ULTIMATE, HEAT VALUE, AND FORMS OF SULFUR ANALYSES FOR SAMPLES FROM THE GREEN RIVER REGION - YAMPA FIELD

	Arithmetic mean (abundance)	Observed range (minimum)	(maximum)	Geometric mean (expected value)	Geometric deviation
		Proximate and ultimate analyses			
Moisture	8.0	5.7	10.9	7.8	1.2
Volatile Matter	37.4	35.2	39.0	37.4	1.0
Fixed carbon	45.9	41.3	52.3	45.8	1.1
Ash	9.0	3.0	17.8	7.7	1.7
Hydrogen	5.4	4.9	5.6	5.4	1.0
Carbon	63.9	59.2	71.0	63.8	1.0
Nitrogen	1.6	1.5	1.9	1.6	1.1
Oxygen	19.8	16.0	23.3	19.6	1.1
Sulfur	0.59	0.5	0.7	0.58	1.1
Heat value (Btu/lb) 1/	11,203	10,400	12,440	11,186	
A.D. loss 2/	2.8	1.58	4.64	2.6	1.4
		Forms of sulfur			
Sulfate	0.02	0.01	0.03	0.014	1.7
Pyritic	0.05	0.01	-.14	0.035	2.7
Organic	0.52	0.43	0.60	0.520	1.1

1/ All values except heat value (Btu/lb) are reported in percent on an "as received" basis.
2/ Air dried loss: percent weight loss of samples dried at 30-35° C.

TABLE 2-5

ARITHMETIC MEAN, OBSERVED RANGE, AND GEOMETRIC MEAN AND DEVIATION OF 15 MAJOR OXIDES AND TRACE ELEMENTS IN THE LABORATORY ASH OF SAMPLES FROM THE GREEN RIVER REGION - YAMPA COAL FIELD.

	Arithmetic mean	Observed range		Geometric mean	Geometric deviation
		Minimum	Maximum		
Ash (%)	9.4	3.3	28.2	8.2	1.7
Si02 (%)	47	31	70	46	1.2
Al203 (%)	24	13.6	31	23	1.2
Ca0 (%)	6.5	2.4	14	5.7	1.7
Mg0 (%)	1.4	0.7	3.1	1.3	1.4
Na2O (%)	0.77	0.15	2.4	0.55	2.3
K20 (%)	0.82	0.28	1.5	0.76	1.5
Fe203 (%)	5.0	1.8	10	4.2	1.7
Mn0 (%)	0.02	0.007	0.15	0.02	2.4
Ti02 (%)	0.89	0.55	1.2	0.90	1.2
S03 (%)	5.5	1.4	13	4.5	1.8
Cd (ppm)	0.80	1.01	1.5	0.74	1.5
Cu (ppm)	78.7	36	162	73.9	1.4
Li (ppm)	94.6	47	167	90.3	1.3
Pb (ppm)	47.5	25	70	45.8	1.3
Zn (ppm)	53.8	35	85	51.3	1.4

TABLE 2-6

ARITHMETIC MEAN, OBSERVED RANGE, AND GEOMETRIC MEAN AND DEVIATION OF THIRTY-SIX ELEMENTS REPORTED ON A WHOLE COAL BASIS FOR THE GREEN RIVER REGION - YAMPA FIELD

Element 1/, 2/	Arithmetic mean	Observed range		Geometric mean	Geometric deviation
		Minimum	Maximum		
Si (%)	2.3	0.54	9.3	1.7	2.1
Al (%)	1.2	0.36	2.3	1.0	1.7
Ca (%)	0.35	0.18	0.55	0.33	1.3
Mg (%)	0.07	0.02	0.14	0.06	1.6
Na (%)	0.05	0.008	0.17	0.03	2.6
K (%)	0.07	0.009	0.35	0.05	2.4
Fe (%)	0.25	0.17	0.38	0.24	1.2
Mn	13.7	3.1	45.6	10.6	2.1
Ti (%)	0.05	0.02	0.09	0.04	1.5
As	1.2	1.03	4.0	0.64	3.2
Cd	0.90	.043	0.30	0.48	3.2
Cu	6.6	3.0	16.7	6.05	1.5
F	108	35	190	99.1	1.5
Hg	0.03	0.013	0.10	0.03	1.8
Li	8.0	3.5	13.2	7.4	1.5
Pb	4.2	1.6	7.0	3.7	1.6
Sb	0.3	0.1	0.70	0.23	1.9
Se	1.0	0.43	1.4	0.97	1.3
Th	2.7	3.03	10.2	1.1	4.2
U	1.0	0.23	2.3	0.85	1.8
Zn	5.1	1.4	12.3	4.2	1.8
B -S	150	50	300	100	1.6

1/ '-S' following the element symbol means that the values listed were determined by semiquantitive spectrographic analysis. The spectrographic results are to be identified with geometric brackets whose boundaries are 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12, etc., but are reported arbitrarily as mid-points of those brackets, 1.0, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, etc. The precision of the spectrographic data is approximately one bracket at 68 percent, or two brackets at 95 percent confidence.

2/ Elements not indicated at (%) are parts per million (ppm).

TABLE 2-6 (Cont.)

ARITHMETIC MEAN, OBSERVED RANGE, AND GEOMETRIC MEAN AND DEVIATION OF THIRTY-SIX ELEMENTS REPORTED ON A WHOLE COAL BASIS FOR THE GREEN RIVER REGION - YAMPA FIELD

Element 1/, 2/		Arithmetic mean	Observed range		Geometric mean	Geometric deviation
			Minimum	Maximum		
Ba	-S	200	70	1,000	150	1.9
Be	-S	--	.20	1.0	--	--
Co	-S	--	.70	5.0	--	--
Cr	-S	2	1.0	7.0	2	1.7
Ga	-S	3	1.0	10.0	3	1.9
Mo	-S	--	0.50	2.0	--	--
Nb	-S	--	0.7	7.0	--	--
Ni	-S	--	1.03	7.0	--	--
Sc	-S	1.5	0.7	5.0	1.5	1.7
SR	-S	150	70	500.0	150	1.8
V	-S	7	3.0	15.0	7	1.5
Y	-S	5	1.0	10.0	3	1.8
Yb	-S	0.5	0.1	1.0	0.3	1.8
Zr	-S	20	7.0	70.0	20	1.7

1/ '-S' following the element symbol means that the values listed were determined by semiquantitive spectrographic analysis. The spectrographic results are to be identified with geometric brackets whose boundaries are 1.2, 0.83, 0.56, 0.38, 0.26, 0.18, 0.12, etc., but are reported arbitrarily as mid-points of those brackets, 1.0, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1 etc. The precision of the spectrographic data is approximately one bracket at 68 percent, or two brackets at 95 percent confidence.

2/ Elements not indicated at (%) are parts per million (ppm).

TABLE 2-7

A RANGE OF ANALYSES OF LOWER WHITE RIVER COAL

Contents	As received - 1,537 samples		
	High	Low	Mean
Moisture (%)	10.80	8.11	9.47
Volatile matter (%)	35.95	31.66	33.86
Fixed carbon (%)	50.50	39.04	44.86
Ash (%)	21.19	4.20	11.82
Sulfur (%)	0.50	0.35	0.43
Btu/lb	11,450	9,360	10,507

Source: Speltz, 1976

The Northwest Colorado Coal Regional Environmental Statement (NWCCRES) Regional Analysis, presents a broad overview of the water resources in the report area with emphasis on the water-yielding characteristics of major streams. The limited data available at the time of preparation of the Regional Analysis, however, did not permit a specific hydrologic appraisal of those areas where coal development is occurring or where future development is expected.

In the interim, several hydrologic studies have been completed or are in progress in the coal areas in Northwestern Colorado. The U.S. Geological Survey (USGS) has cased and finished as observation wells 65 coal test holes drilled by the U.S. Bureau of Mines. These wells will be measured periodically to monitor future changes in water levels and water quality in conjunction with coal development. A reconnaissance of ground-water resources between Craig and Steamboat Springs was recently completed by Brogden and Giles (1977). The report presents water level and quality of water data for 79 wells and springs. Hydrologic studies related to coal development in the Yampa River Basin are currently being conducted by the USGS in cooperation with the Bureau of Land Management (BLM), the U.S. Environmental Protection Agency, the U.S. Forest Service, Routt County Department of Environmental Health, Routt County, the Upper Colorado River Compact Commission, and the Colorado River Water Conservation District. A report describing those studies (U.S. Geological Survey 1976) presents chemical and physical data for 252 wells and springs and laboratory analyses for water samples collected at 119 sites on streams in the area.

Perhaps most important, however, water-discharge and water-quality records are being collected by the USGS in cooperation with the BLM on seven small streams that drain coal areas (Table 2-8 and Map 2-1). These data are believed to be generally representative of runoff from the coal areas. Records for 1975 and 1976 water years are published in basic data reports (USGS 1977a, b).

Hydrologic data obtained from the above studies, although minimal and subject to uncertainty because of the short period of record, provide a basis for approximating general conditions of groundwater occurrence in and for estimating quantity and quality of surface runoff from the coal areas. Data for the coal areas reveal some interesting hydrologic relationships between those areas and the overall report area. Apparent relationships, however, are necessarily very generalized and may not apply to specific mine areas.

Ground Water

Existing and potential coal-development tracts in northwestern Colorado typically occur in those areas where structural deformation and differential erosion have exposed coalbearing formations at or near the

TABLE 2-8

GAGING STATIONS ON STREAMS DRAINING COAL AREAS 1/

Station number	Station name	Location	Section	Township	Range
09243700	Middle Creek near Oak Creek	SW¼NE¼	13	5N	86W
09243800	Foidel Creek near Oak Creek	NW¼SW¼	31	5N	86W
09243900	Foidel Creek at mouth, near Oak Creek 2/	SE¼NE¼	14	5N	86W
09250400	Good Spring Creek near Axial	SW¼NE¼	26	4N	93W
09250510	Taylor Creek at mouth, near Axial	NW¼SW¼	14	4N	93W
09250600	Wilson Creek near Axial 2/ 3/	NW¼SW¼	14	4N	93W
09250610	Jubb Creek near Axial	SE¼SE¼	16	4N	93W

1/ Parameter list

Daily:

Physical - Specific conductance, suspended sediment, and temperature.

Monthly:

Chemical - Bicarbonate; and dissolved boron, calcium, chloride, fluoride, iron, manganese, magnesium, nitrite plus nitrate, orthophosphate, potassium, silica, sodium, solids, and sulfate.

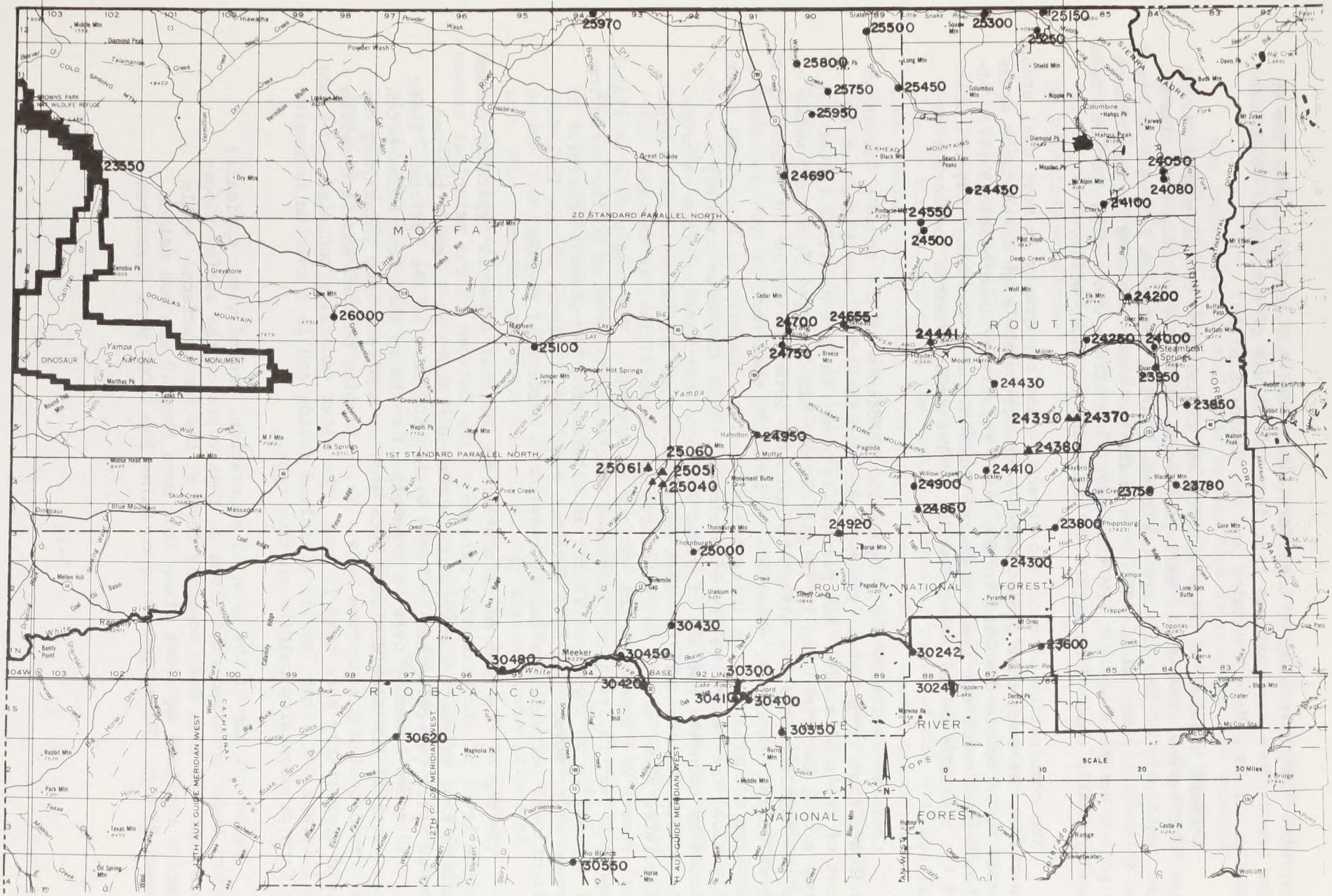
Physical - Dissolved oxygen, pH, specific conductance, and temperature.

Quarterly:

Chemical - Dissolved antimony, arsenic, cadmium, copper, lead, mercury, nickel, vanadium, zinc, and dissolved and total organic carbon.

2/ Samples collected daily for suspended sediment only.

3/ Samples collected weekly for physical parameters other than suspended sediment.



▲ Stations on streams draining coal areas

25340, an abbreviated identification number, refers to an 8 digit station number 09253400

Map 2-1. Locations of surface water gaging stations

surface. Not surpisingly, therefore, most coal-development tracts lie on the broad dip-slope surfaces that form the flanks of anticlinal folds such as the Williams Fork Mountains and the Danforth Hills.

Streams heading on these uplifts and draining to the principal rivers have cut narrow steep-sided valleys several hundred feet deep that disrupt the continuity of the dipslope surfaces, leaving segmented interstream areas up to several miles wide. The more resistant sandstone beds on which these dipslope surfaces are cut and the underlying strata containing the coal beds are typically exposed on strike in the sides of these valleys.

The combination of geologic structure and topography in most coal areas, therefore, is such that ground-water recharge on the high interstream areas tends to percolate downward to the first relatively impermeable layer. Although some water continues downward through these "perching" layers, most of the recharge is deflected downdip or laterally towards the bordering valleys.

Characteristically steep hydraulic gradients in the downdip direction indicate that ground-water movement downdip is significantly impeded in most of the coal areas. Low permeability may be a controlling factor in some areas, but yields up to 10 gallons per minute (gpm) from many wells on the dipslope surfaces attest to moderate permeability in the proximity of these wells. Moreover, observations indicate that most of the ground-water recharge occurring on the interstream dipslope surfaces is discharged laterally along the nearby valley side slopes. This discharge commonly is evidenced by elongate patches of giant wild rye that parallel rock outcrops. The additional moisture provided by ground-water discharge in these areas stimulates plant growth but generally is not sufficient to saturate the soil veneer and appear at the surface as springs. The meager data available suggests that faulting and increased fracturing transverse to the direction of dip may be an important factor in determining the observed patterns of ground-water movement. More data are required, however, before inferred directional permeability can be related to structural trends.

The top of the zone of saturation in the coal areas is typically graded to the level of the perennial streams in the bottoms of the principal stream valleys that transect the dipslope surfaces. Above this level, perched ground water generally can be found within 100 feet of the surface. These perched zones commonly overlie unsaturated rocks so that test holes often show vertical drainage downward from shallow aquifers into underlying unsaturated coal and sandstone beds. Wells tapping perched aquifers seldom yield appreciably more than 10 gpm. The water generally contains 750-1,500 (milligrams per liter (mg/l)) dissolved solids and is a calcium magnesium sulfate or magnesium calcium sulfate type.

Below the top of the zone of saturation, ground water typically occurs under confined conditions so that wells on the valley floors more than 200 feet deep commonly flow at the land surface. Wells tapping confined aquifers often flow more than 10 gpm but seldom exceed 25 gpm. Water generally contains 500-1,000 mg/l dissolved

solids and is typically a sodium bicarbonate type with lesser amounts of calcium, magnesium, and sulfate.

The importance of coal beds as aquifers in northwestern Colorado is uncertain but available data indicate that most wells in the coal areas obtain water from sandstone beds and not from coal. The reason is tentatively attributed to the preponderance of sandstone in rocks underlying these areas rather than to any quantity or quality of water considerations. Coal beds may be drained where they lie above the top of the saturated zone, but below that level, they must be regarded as potential aquifers.

Variations in ground-water discharge within the coal areas and the relative significance of that discharge to the total water yield of the report area are poorly defined. In general, however, greatest recharge and, consequently, greatest contribution of ground-water flow to streams occurs in the south and eastern parts of the coal area, where precipitation is highest. Conversely, lowest ground-water contribution to streamflow occurs in the central and western parts of the coal area, where precipitation is lowest. For example, ground-water effluent indicated by base flow at the stations listed in Table 2-8, which lie in the southern and eastern parts of the coal area, averages about 7 acre-feet per square mile per year (ac-ft/sq-mi/yr). Most streams in the central and western parts of the area have no base flow.

Assuming an average annual base flow (ground-water effluent) from the overall coal areas of as much as 4 ac-ft/sq-mi and no evapotranspiration losses enroute to the principal rivers, total ground-water contribution from the 1,004 square miles of coal area (Federal Register Vol. 39, no. 1, Feb. 13, 1974, and MFP update for lower White River coal field) would be about 4,000 acre-feet. That represents less than 0.3 percent of the annual water yield from the report area. Actually, significant evapotranspiration losses are probably occurring. The above figures, therefore, should be high and, thus, further emphasize the relatively insignificant effect of ground-water effluent from the coal areas on the total water budget.

Following the above logic, dissolved solids contributed by ground-water effluent from the coal areas to the rivers in the report area should average no more than 3,800 tons annually. This is about 1 percent of the total dissolved solids yielded annually by rivers draining the report area.

Surface Water

Surface runoff from the coal areas ranges widely in quantity from one part of the report area to another. Highest annual runoff typically occurs from the eastern coal tracts where precipitation is highest, whereas lowest annual runoff occurs from the western tracts where precipitation is lowest. Conversely, highest peak discharges per unit area of watershed typically occur from western tracts where runoff is generated largely by high-intensity convectional storms, whereas lowest peak discharges per unit area of watershed typically occur from eastern tracts where runoff is generated largely by spring snow melt.

Differences in runoff from the various coal tracts, however, are dwarfed in comparison to differences between the coal areas and the mountain areas. Table 2-9 shows that annual runoff from the coal areas (based on 2 years of record) averages only about 0.8 inch, whereas annual runoff from the mountain areas averages more than ten times that amount and is as high as 27 times that amount for runoff from the Elk River watershed. Assuming an average annual runoff of 0.8 inch, total annual runoff from the coal areas would be about 43,000 acre-feet. This is less than 3 percent of the total runoff from the Yampa River subbasin (Table 2-10). Because of evapotranspiration losses from streams draining the coal areas and because of the lack of data from low runoff watersheds in the western part of the report area (Table 2-9), actual water yield from the coal areas probably is significantly less than 43,000 ac-ft/yr. If so, water yield from the coal areas may be as little as 1 percent of the total runoff from the report area.

Table 2-9 shows that measured peak discharges per unit area from the gaged coal areas are unusually small for watersheds smaller than 35 square miles. Small watersheds characteristically have much higher unit peak discharges than large watersheds, often exceeding 100 ac-ft/sq-mi. In Table 2-9, streams draining the mountains have unit peak discharges more than an order of magnitude higher than those draining the comparatively small coal watersheds. This apparent anomaly may be attributed in part to the short period of record for streams draining coal areas and in part to the location of the gaged streams in the southcentral and eastern parts of the report area, where most runoff is generated by spring snow melt rather than by summer convectional storms.

Field observations, however, indicate that most streams draining coal tracts show little or no indications of high peak discharges. Apparently, the sandy soils in most coal areas and the permeable clinker formed by local burning of coal beds absorb most of the rainfall, thereby minimizing runoff. An exception may occur in the western part of the

TABLE 2-9

HYDROLOGIC DATA FOR STREAMS DRAINING MOUNTAIN AND COAL AREAS
IN NORTHWESTERN COLORADO

Station 1/	Station number 2/	Drainage area (sq-mi)	Average annual runoff 1/ (ac-ft)	(ac-ft/sq-mi)	(inches)	Peak discharge 1/ (cfs)	(cfs/sq-mi)	Minimum discharge (cfs)	Annual suspended sediment load (tons)	(tons/sq-mi)
Streams draining mountain areas										
Yampa River at Steamboat Springs	09239500	604	339,100	560	10.5	6,820	11.3	4.0	--	--
Yampa River near Hayden	09244410	1,430	762,200	530	10.0	16,500	11.5	24	--	--
Yampa River near Maybell	09241000	3,410	1,124,000	330	6.2	17,900	5.2	2.0	300,000 3/	88
Elk River at Clark	09241000	206	244,200	1,190	22.2	4,470	21.7	22	--	--
Elkhead Creek near Elkhead	09245000	64.2	38,250	600	11.2	1,660	25.9	0	--	--
S. Fk. Williams Fk. River near Pagoda	09249200	46.7	31,660	680	12.7	910	19.5	0.02	--	--
Milk Creek near Thornburgh	09250000	65	17,820	270	5.1	1,050	16.2	0.2	--	--
Streams draining coal areas										
Middle Creek near Oak Creek	09243700	23.5	1,550	66	1.2	20	0.8	0	--	--
Foidel Creek near Oak Creek	09243800	8.6	130	15	0.3	1	0.1	0	18 E 4/	2
Foidel Creek at mouth	09243900	17.5	1,670	95	1.8	69	3.9	0	--	--
Good Spring Creek at Axial	09250400	35	1,430	41	0.8	18	0.5	0.15	250 E	7
Taylor Creek at mouth	09250510	7.2	23	3	0.1	7	1.0	0	167 E	23

TABLE 2-9 (cont.)

HYDROLOGIC DATA FOR STREAMS DRAINING MOUNTAIN AND COAL AREAS
IN NORTHWESTERN COLORADO

Station 1/	Station number 2/	Drainage area (sq-mi)	Average annual runoff 1/ (ac-ft)	(ac-ft/sq-mi)	(inches)	Peak discharge 1/ (cfs)	(cfs/sq-mi)	Minimum discharge (cfs)	Annual suspended sediment load (tons)	(tons/sq-mi)
Streams draining coal areas (cont'd)										
Wilson Creek near Axial	09250600	22	1,293	59	1.1	33	1.5	0.31	1,672 5/	76
Jubb Creek near Axial	09250610	7.5	59	8	0.2	6	0.8	0	280 E	38

1/ Based on only 2 years of record for streams draining coal areas.
2/ Location of stations is shown in Figure 2-1.
3/ From records collected during the period 1950-58.
4/ E - estimated from random samples collected during 1976 water year.
5/ Based on 1976 water year.

TABLE 2-10

EXISTING CONSUMPTIVE WATER USE AND WATER QUALITY IN YAMPA RIVER SUBBASIN
WITHOUT DEVELOPMENT OF NEW FEDERAL COAL 1/

	Supply, consumption, and quality categories	Present
1	Total undepleted supply (ac-ft); 2/	1,702,400
2	Consumptive use:	
3	Irrigation (ac-ft)	69,700 3/
4	Reservoir evaporation (ac-ft)	9,300 4/
5	Riparian vegetation (ac-ft)	18,000
6	Power plants (ac-ft)	4,000
7	Municipal and rural (ac-ft) 5/	1,400
8	Export from basin (ac-ft) 6/	10,600
9	Existing mines (ac-ft)	200
10	Net discharge without development (ac-ft) 7/	1,589,200
11	Water quality (polluting sources):	
12	Natural sources (tons)	335,000
13	Irrigation (tons)	80,000
14	Municipal wastes (tons) 8/	700
15	Existing mines (tons)	7,500
16	Less load due to power plants and exports (tons)	-2,300
17	Dissolved solids in Yampa River (tons) (lines 12 through 16)	420,900
18	Discharge weighted average of dissolved solids in Yampa River (mg/l) without development	194.8
19	Increase in dissolved solids in Colorado River below Hoover Dam without development (mg/l) 9/	0 10/

1/ Update from Table RII-7, NWCCRES.

2/ Irons and others, 1965.

3/ 71,400 - (2,390 x 0.7) = 69,700.
71,400 ac-ft = 102,000 ac x 0.7 (ac-ft water applied per acre).
2,390 = irrigated acreage on Vermillion Creek (from Division of Water Resources).

4/ From CWCB & USDA, 1969.

5/ Based on use of 150 gal gal/day/person with 50 gal/day consumed and 100 gal/day returned to streams as sewage. Population projections are from Table 1-5.

6/ Transbasin diversions from Little Snake River drainage to Hog Park Creek (North Platte River Basin) and from Bear River Drainage to Egeria Creek (Colorado River Basin).

7/ No development other than power plants under construction.

8/ Based on 100 gal/sewage/day/person and increase in dissolved solids load of 200 mg/l.

9/ Includes both the effects of diversions and increased dissolved solids loading.

10/ Present is assumed to be base level against which future changes are compared.

study area near Rangely, where most precipitation is generated by high-intensity convectional storms. There, eroding channels indicate high peak discharges, but no runoff records are available.

Available data, therefore, indicate that, because of the short period of record, unit peak discharges listed in Table 2-9 are probably low for streams draining coal areas. Nevertheless, excessive flooding appears to be uncommon in most of the coal areas.

Data on water quality presented in Table 2-11 show significant differences between streams draining the mountains and streams draining coal areas. Snowmelt runoff from the mountains is typically a calcium bicarbonate water that contains less than 175 mg/l dissolved solids during the spring period. As snow-melt contribution to these streams decreases during the summer and fall and flow is increasingly derived from ground-water discharge, dissolved solids concentrations increase about three fold, to as much as 450 mg/l. Concentrations of sodium and sulfate ions generally increase, but not sufficiently to change the water type.

In contrast, runoff from the coal areas commonly contains more than 700 mg/l dissolved solids during the spring and fall, about three to four times the corresponding values for mountain areas. No single water type characterizes the coal areas. The easternmost areas yield sodium bicarbonate water like the nearby mountains. Water from the Danforth Hills coal field is dominantly a magnesium calcium bicarbonate with significant amounts of sodium and sulfate present. No water-quality data are available on runoff from the western part of the report area.

Assuming an average dissolved solids concentration in runoff from the coal areas of about 900 mg/l (average of values listed in Table 2-11) and a maximum average annual runoff of 43,000 ac-ft, total dissolved solids load in runoff from the coal areas would be about 53,000 tons/yr. This is about 18 percent of the dissolved solids yielded by the Yampa River subbasin (Table 2-10). As previously stated, however, annual runoff from the coal areas is probably somewhat less than 43,000 ac-ft because of evapotranspiration losses and minimal runoff from the more arid tracts. If so, the above figures would be less, accordingly.

A comparison of suspended sediment loads yielded by the coal areas with that yielded by the overall report area is probably not warranted by the meager data in Table 2-9. However, the estimated annual unit suspended sediment yields from the coal watersheds (Table 2-9) were all less than the corresponding value for the Yampa River at Maybell. Normally, sediment yield per unit area of watershed decreases progressively with increasing size of a basin because of deposition of a part of the load as flows move downstream. For example, Hadley and Schumm (1961) report that sediment yields on Lance Creek in eastern Wyoming decreased from 1.10 ac-ft/sq-mi in the head water areas to 0.33 ac-ft/sq-mi on the main stem, as the size of the watershed in-

TABLE 2-11

QUALITY OF WATER DATA FOR STREAMS DRAINING MOUNTAIN AND COAL AREAS
IN NORTHWESTERN COLORADO

Station	Station number 1/	pH		Specific conductance 2/ (microhoms/cm)		Water type 3/	
		Range	Avg.	Spring	Fall	Spring	Fall
Streams draining mountain areas							
Yampa River near Hayden	09244410	7.4-8.4	7.9	80-200	280-400	Ca,HCO_3	Ca,HCO_3
Yampa River below Elkhead Creek	09246550	7.3-8.6	8.2	100-250	400-650	Ca,HCO_3	Ca,Na,HCO_3,SO_4
Yampa River below Craig	09247600	7.4-8.9	8.3	78-200	400-600	Ca,HCO_3	Ca,Na,HCO_3,SO_4
Williams Fork at mouth	09249750	7.6-8.6	8.3	175-220	400-500	Ca,HCO_3	Ca,HCO_3
Yampa River near Maybell	09251000	7.5-8.7	8.0	100-200	500-600	Ca,HCO_3	Ca,Na,HCO_3
Streams draining coal areas							
Middle Creek near Oak Creek	09243700	7.6-8.8	8.2	400-500	600-850	Ca,HCO_3	Ca,HCO_3
Foidel Creek near Oak Creek	09243800	7.5-7.8	7.8	500-800	800-900	Ca,HCO_3	Ca,HCO_3
Foidel Creek at mouth	09243900	7.4-8.2	7.9	1,000-1,200	1,200-1,400	Ca,SO_4	--
Good Spring Creek at Axial	09250400	8.1-8.8	8.2	1,400-1,500	1,400-1,500	Mg,Ca,HCO_3,SO_4	Mg,Ca,SO_4,HCO_3
Taylor Creek at mouth	09250510	8.1-8.5	8.2	1,000-1,150	1,300-1,450	Mg,Ca,HCO_3	Ca,Mg,Na,HCO_3,SO_4

1/ Location of stations is shown in Figure 2-1.
2/ Dissolved solids concentrations in milligrams/liter (mg/l) can be approximated by multiplying specific conductance by 0.7.
3/ Ca, calcium; Mg, magnesium; Na, sodium; HCO_3, bicarbonate; SO_4, sulfate. Underline indicates dominant ions.

TABLE 2-11 (Cont.)

QUALITY OF WATER DATA FOR STREAMS DRAINING MOUNTAIN AND COAL AREAS
IN NORTHWESTERN COLORADO

Station	Station number 1/	pH		Specific conductance 2/ (microhoms/cm)		Water type 3/	
		Range	Avg.	Spring	Fall	Spring	Fall
Streams draining coal areas (cont.)							
Wilson Creek near Axial	09250600	7.5-8.5	8.1	1,500-1,800	1,800-2,600	Na,Ca,Mg,HCO_3,SO_4	Na,Mg,Ca,HCO_3,SO_4
Jubb Creek near Axial	09250610	7.8-8.4	8.1	1,500-1,600	1,500-2,100	Mg,Ca,Na,HCO_3,SO_4	Mg,Ca,Na,HCO_3,SO_4

1/ Location of stations is shown in Figure 2-1.
2/ Dissolved solids concentrations in milligrams/liter (mg/l) can be approximated by multiplying specific conductance by 0.7.
3/ Ca, calcium; Mg, magnesium; Na, sodium; HCO_3, bicarbonate; SO_4, sulfate. Underline indicates dominant ions.

creased from about 0.5 to about 2,000 square miles. On that basis, unit sediment yields from the small coal areas listed in Table 2-9 would be expected to be three to four times as high as that from the Yampa River at Maybell.

Table 2-9 shows that the highest annual suspended sediment load from the gaged coal areas was measured on Wilson Creek near Axial. This is consistent with field observations, which show that the Wilson Creek channel is entrenched and eroding for a distance of about 4 miles upstream from the gaging station. Other streams listed in Table 2-9 are comparatively stable or have channel reaches where sediment deposition is occurring upstream from the gaged sites.

The average annual suspended sediment load (Table 2-9) for streams draining coal areas is only 29 tons/sq-mi, about one-third the load in the Yampa River at Maybell. These data, although inadequate for computing sediment yield from the coal areas, tend to confirm field observations indicating that coal areas in the south-central and eastern parts of the report area are generally stable and contribute comparatively little sediment to the principal streams.

No data are available for the western coal areas, which are comparatively arid and subject to locally high rates of channel and upland erosion. Sediment yield from this part of the coal area probably exceeds 500 tons/sq-mi/yr, which is more than 17 times as high as the corresponding sediment yield from coal areas in the south-central and eastern parts of the report area. Most of this high sediment load is entering the White River and moving downstream into storage reservoirs on the Colorado River, reducing their useful life expectancy.

Alluvial Valley Floors

Preservation of the hydrologic function of alluvial valley floors is emphasized in the Surface Mining Control and Reclamation Act (SMCRA) of 1977 (see Chapter 1, Related Reviews, Identification of Alluvial Valley Floors). The term alluvial valley floors refers to those unconsolidated stream-laid deposits holding streams where water availability is sufficient for subirrigation or flood irrigation agricultural activities. Not included in this category are those upland areas that are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion, deposits by unconcentrated runoff or slope wash, together with talus, other mass movement accumulation, and windblown deposits.

Technically, the identification of alluvial valley floors requires hydrologic data for both surface- and ground-water resources collected over a period sufficiently long to appraise the adequacy of the water supply for agricultural activities. These data are not currently available

for most streams draining the coal areas. From a practical standpoint, however, the adequacy of the water supply for agricultural activities at any given location can be equated with ongoing farming operations. The perennial need for additional forage for livestock in the report area coupled with farming and ranching experience over many decades have led to the development of virtually all those valley floors where agricultural activities are economically feasible.

On that basis, it is possible to approximate the significance of alluvial valley floors to surface coal mining in the study area. Observations show that the lower reaches of most perennial and some intermittent stream valleys in the Yampa and Danforth Hills coal fields undoubtedly qualify as alluvial valley floors. In contrast, the Lower White River coal field in the arid western part of the report area has no alluvial valley floors.

The Office of Surface Mining is developing criteria which will technically define alluvial valley floors. These criteria should be completed in October, 1978.

The study area is one of geographical and meteorological complexity. Climatic conditions vary widely within short distances. Rugged mountains, deep valleys and canyons, and large plateaus or mesas characterize the terrain. The mountains of the Continental Divide provide an effective barrier to moisture-laden air that reaches into the Great Plains from the Gulf of Mexico. The basic types of climate are (1) semiarid and (2) undifferentiated highlands (Trewartha 1961). Temperatures are cold in winter and, except for the higher elevations, warm in summer. Precipitation falls mostly from air of Pacific origin and occurs most frequently during the summer half of the year. Occurrences of severe weather are infrequent.

Variation in weather are related to synoptic-scale high and low pressure systems that move with the mid-latitude westerlies. From fall to spring, considerable snowfall occasionally accompanies the low pressure storms. Prevailing winds are westerly over the higher elevations and are highly dependent on the valley orientiation in the lower valleys.

Temperature

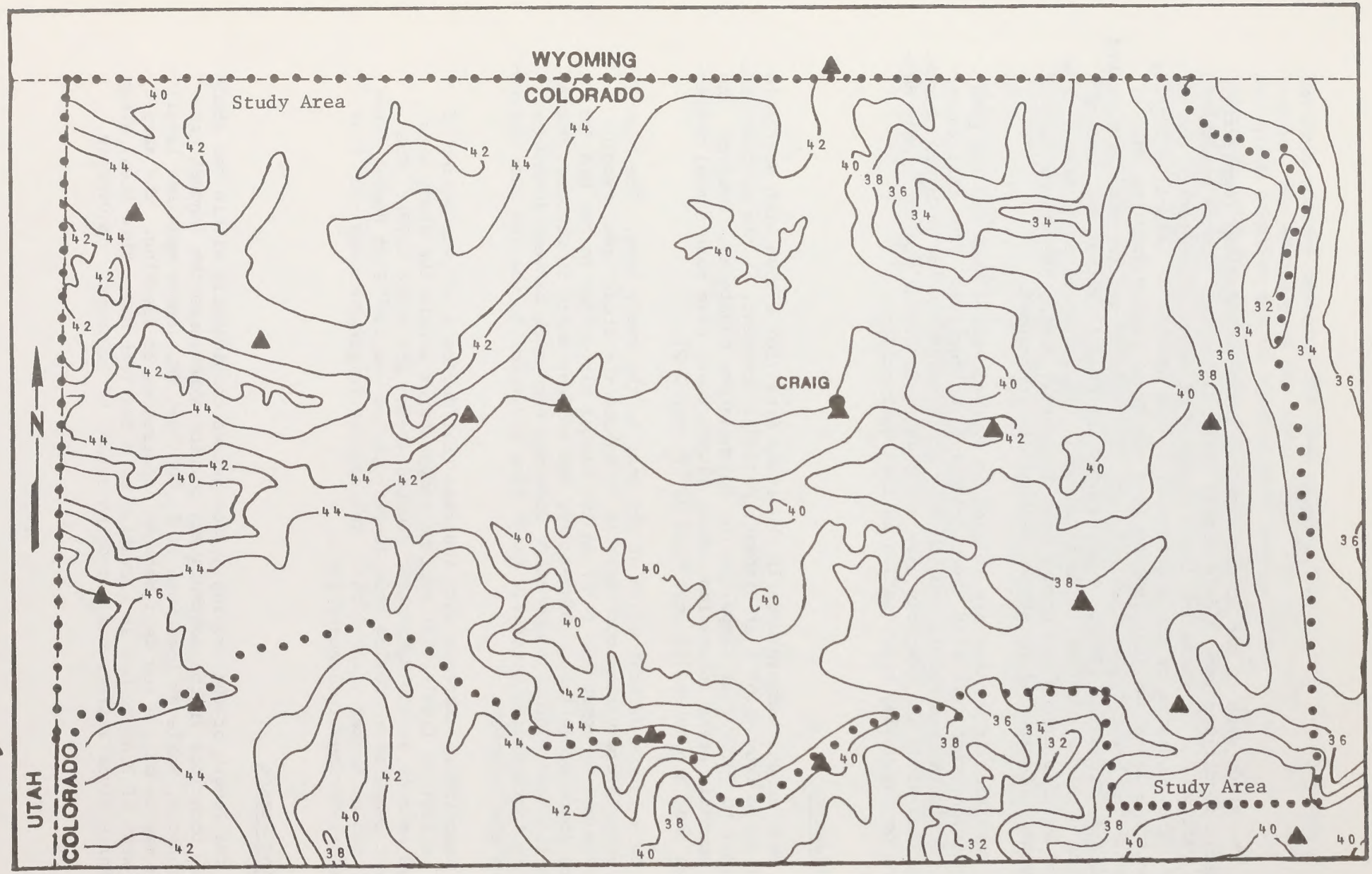
Mean annual temperatures in the study area (for cities with available data) range from 46.5° F at Dinosaur National Monument, in the southwestern portion, to 39.0° F at Yampa, in the southeastern mountains. However, the high mountain areas (elevations about 11,000 feet) have mean annual temperatures that are generally less than 32° F (Map 2-2).

July is the warmest month of the year in the study area. The mean July temperature varies considerably thoughout the study area, ranging from the mid to upper 50s (° F) in the higher elevations to the mid 70s in the lower elevations. Conversely, the coldest month is January, during which the mean monthly temperature does not vary much between locations. January temperatures generally range from mid teens to the low 20s, depending on the location.

Temperature extremes data indicate that during a 20-year period of data collection (1951-1970) extreme temperatures within the study area ranged as much as 150 Fahrenheit degrees (Benci and McKee 1977). The warmest temperature during this 20-year period was 100° F at Hayden (June 1956) and at Meeker (June 1954). The coldest temperature was -50° F at Steamboat Springs in January 1963.

Growing Season

The length of the growing season varies considerably within the study area. Locations in the southwestern portion experience the longest growing seasons, while at locations of 12,000 feet MSL (above mean sea level) there may be only a few days between occurrences of freezing. The area just west of Rangely has an elevation of 5,224 feet MSL. This area, along the White River Valley, has a growing season of 120 days. Conversely,



Map 2-2

MEAN ANNUAL TEMPERATURE IN DEGREES FAHRENHEIT
FOR THE STUDY AREA*

*Triangles represent data points used.

Steamboat Springs, one of the highest stations in the study area with growing season data, can expect only 28 consecutive days with minimum temperatures above 32° F.

Since some species of plants are vulnerable to light freezes while others are affected only by hard freezes, growing season data for temperatures of 32°F, 28°F, 24°F, 20°F, and 16°F are shown in Table 2-12.

Consideration of the date of the first fall freeze is particularly important when attempting to revegetate stripped areas. To ensure vegetation survival during the winter, seedlings of grass, shrubs, or trees that are used for revegetation may need to be mature before the first day with a freezing or sub-freezing temperature. The average day of the first occurrence of 32° F at Rangely is approximately mid-September, while at Steamboat Springs the first freeze normally occurs on July 21.

Precipitation

Precipitation (rainfall plus the water equivalent of snowfall) over most of the study area is relatively low compared to other areas of the United States. High elevation is a major cause of this, since the water content of the atmosphere generally decreases with height. About 91 percent of the land in the study area lies above 6,000 feet MSL, so the amount of moisture available for precipitation is relatively low with respect to other places in the nation.

Precipitation amounts vary strikingly over the study area. The extreme southwestern portion, just west of Rangely, receives less 8 inches, while the highest mountain peaks, in the eastern portion, receive over 30 inches. Map 2-3 shows the isohyet pattern resulting from the analysis of precipitation data for the study area. August is the month with the highest amount of precipitation during the year, when approximately 11 percent of the total annual precipitation falls. Conversely, approximately 7 percent of the annual total falls during each of the months of March, October, and November, making these the driest months during the year.

Snowfall

Snowfall totals are highly dependent on terrain elevation and on orientation of mountains and mountain ranges. The terrain elevation within the study area ranges from 5,224 feet (about 4 miles west of Rangely, in the southwestern portion of the study area) to 12,180 feet (at Mount Zirkel, in the northeastern border of the study area). Annual snowfall totals at these locations range from less than 30 inches to more than 400 inches, respectively.

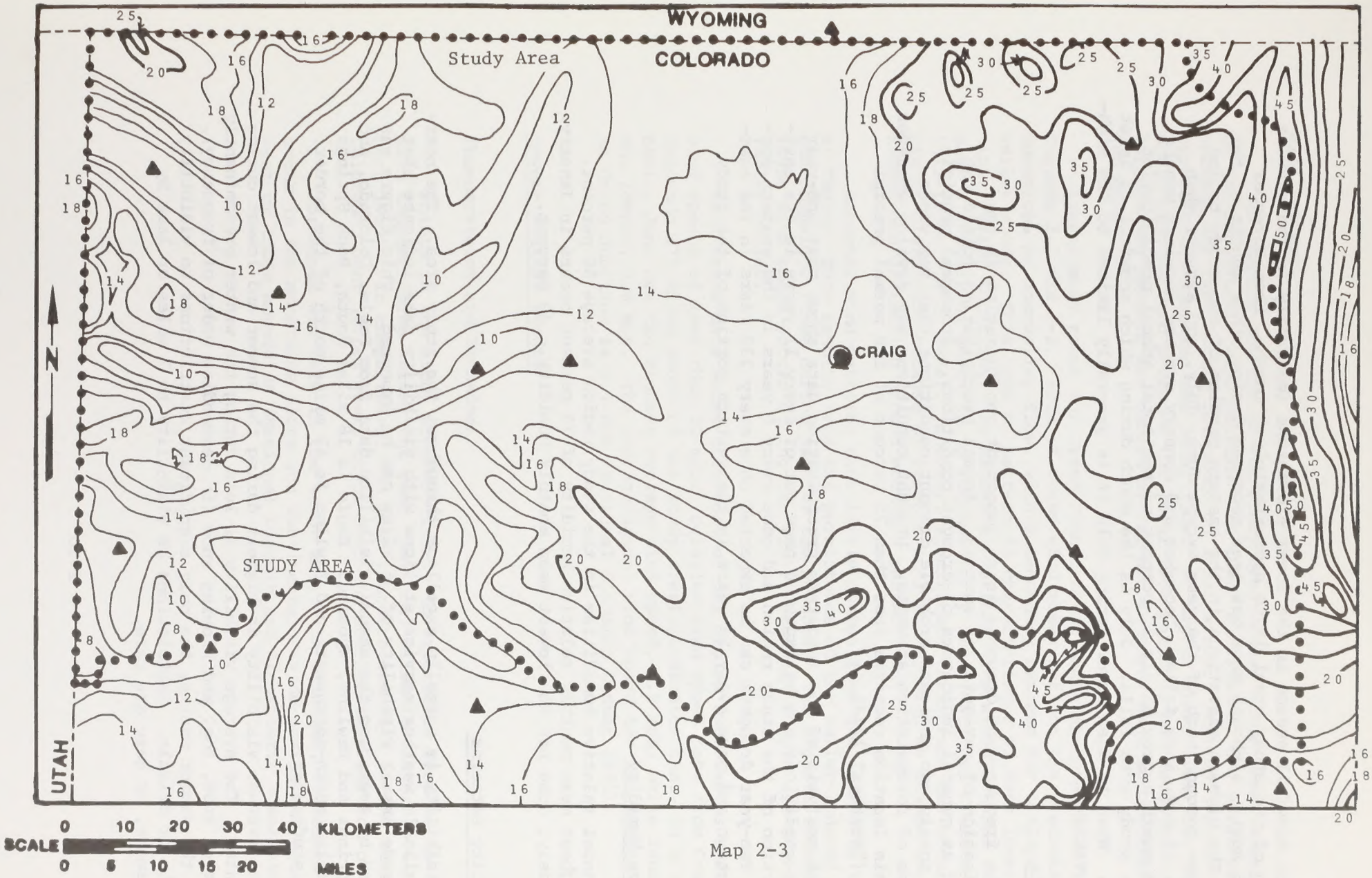
TABLE 2-12

GROWING SEASON DATA FOR LOCATIONS IN OR NEAR THE STUDY AREA

Station	Elevation (ft)	Average number of days between the last spring occurrence and the first fall occurrence of indicated temperatures (°F)					Average dates of first occurrence in the fall of the indicated temperatures (°F)					Average dates of last occurrence in the spring of the indicated temperatur (°F)				
		32°	28°	24°	20°	16°	32°	28°	24°	20°	16°	32°	28°	24°	20°	16°
Craig	6,285	94	120	151	173	202	9/10	9/21	10/3	10/14	11/2	6/8	5/24	5/5	4/24	4/14
Dixon, Wyoming 1/	6,360	83	114	141	167	199	9/1	9/19	9/30	10/13	10/25	6/10	5/28	5/13	4/29	4/9
Eagle FAA Airport 1/	6,497	70	101	135	161	188	8/28	9/11	9/26	10/6	10/21	6/19	6/2	5/14	4/28	4/16
Green Mt. Dam 1/	7.740	82	122	152	173	191	8/31	9/22	10/2	10/16	10/28	6/10	5/23	5/3	4/26	4/20
Hayden	6,375	76	112	145	172	206	8/26	9/16	10/1	10/15	10/28	6/11	5/27	5/9	4/26	4/5
Little Hills 1/	6,140	59	93	119	148	166	8/21	9/11	9/23	10/3	10/10	6/23	6/10	5/27	5/8	4/27
Meeker	6,242	91	123	143	177	204	9/10	9/23	10/2	10/19	10/31	6/11	5/23	5/12	4/25	4/10
Steamboat Springs	6,770	28	80	123	152	182	7/21	8/27	9/18	10/1	10/14	6/23	6/8	5/18	5/2	4/15
Sunbeam 7SW 2/	5,861	52	100	131	156	187	8/8	9/9	9/24	10/5	10/21	6/17	6/1	5/16	5/2	4/17
Vernal RS, Utah 1/	5,280	118	146	177	198	218	9/25	10/4	10/19	10/27	11/6	5/29	5/11	4/25	4/12	4/3

1/ Outside of study area.
2/ Number of miles and direction that the station is located away from the main Post Office.

Sources: National Oceanic and Atmospheric Administration, 1974;
U.S. Department of Commerce, 1896-1976;
U.S. Department of Commerce, 1898-1976;
U.S. Department of Commerce, 1898-1975.



Map 2-3

MEAN ANNUAL PRECIPITATION IN INCHES FOR
THE STUDY AREA*

*Triangles represent data points used. Periods of record used for analysis vary from seven years to 42 years, most of the records ending in 1972.

The snowfall season in the lower elevations (generally in the western portion of the study area) lasts approximately 6 months, from November through April, although snow has been reported during other months of the year. The highest elevations in the eastern portion of the study region have snow through much of the year except June, July, and August, when little, if any, snow falls. December and January are the snowiest months; in each month approximately 20 percent of the total annual precipitation for the study area falls. July is the month during which snowfall is least likely. When it does occur during July it is generally limited to the highest elevations.

Droughts

The frequency of droughts is an important consideration in the determination of revegetation success. Annual precipitation totals can be used as general indicators of drought conditions. Subnormal precipitation totals can indicate probable drought conditions that may cause failures of revegetation attempts. Drought conditions may develop whenever a certain location receives less than 75 percent of its normal precipitation ("Weather" 1974).

The analysis of the long-term precipitation data shows that one-year drought conditions can be expected once out of every 11 years in the eastern portion of the study region and once every 5 years in the western portion. Two-year droughts can be expected once every 132 years in the eastern portion and once every 29 years in the western portion of the study area.

Relative Humidity

Annual relative humidities in the study region average 58 percent. The highest mean monthly relative humidity of 75 percent occurs in January. Conversely, June has the lowest mean monthly humidity - 49 percent.

Visibility Patterns

Visibility is normally excellent throughout the study area. The nearest available weather service stations with visibility data indicate that an average annual visibility of 26 miles can be expected. This figure was obtained by averaging the annual visibility data from Eagle, Colorado, and Rock Springs and Rawlins, Wyoming. Eagle is 18 miles south, Rock Springs is 40 miles north-northwest, and Rawlins is 53 miles north of the border of the study area.

The average visibility is highest during the summer and lowest during the winter. The average visibility is less during the winter predominantly because of snow, fog, and blowing snow (in descending order of frequency). During the summer months, the only significant restrictions to visibility are rain or drizzle. Restrictions of visibility to 7 miles or less by dust, smoke, or haze are rare.

Wind Patterns

The complex terrain of the study area causes major local distortion of the large-scale wind pattern. At lower elevations, the large-scale flow pattern has very little influence on local winds. Instead, valley-induced circulations dominate the local flow. At higher elevations, the large-scale wind pattern produces the local flow pattern, but deviations from the large-scale pattern are caused by terrain features such as mountain ridges and peaks.

Annual wind roses for Grand Junction and Eagle are presented in Figures 2-1 and 2-2. Both of these wind roses reflect the predominance of downslope or downvalley flow, with a secondary maximum for upslope or up-valley winds. This type of pattern is characteristic of most lower elevation, valley locations. At higher elevations, the wind patterns tend to have a prevailing westerly to southwesterly flow (National Climatic Center 1971-1976; N.M.C. 1964). However, significant variations can occur at higher elevations because of terrain influences, such as channeling by ridges and deflection around mountain peaks.

Seasonal wind patterns show little change from one season to the next at Eagle. This results from the persistence of the valley-induced upslope and downslope flows during each of the seasons. The highest frequency of light wind speed occurs during the winter because of cold air settling into valley basins.

Wind speed data shows that most of the region experiences annual average wind speeds of less than 10 mph. Detailed wind speed data from Grand Junction, Colorado (75 miles south of the study area), indicates that, on a monthly basis, June has the highest average wind speed, 9.8 mph, while January has the lowest, 5.6 mph. The average annual wind speed for the period 1941-1970 at Grand Junction is 8.1 mph (National Climatic Center 1971).

Severe Weather Events

Thunderstorms and Tornadoes

Points in the study area are likely to experience from 33 to 43 days with thunderstorms during the year (National Climatic Center 1976; Landsberg 1969). In comparision, the most thunderstorm days in the state of Colorado, over 70 per year, occur over the southeastern portion of the state.

Tornadoes are rare in the study area. In Colorado, tornadoes rarely occur in the mountains along the Continental Divide and in the areas west of those mountains (National Oceanic and Atmospheric Administration 1974).

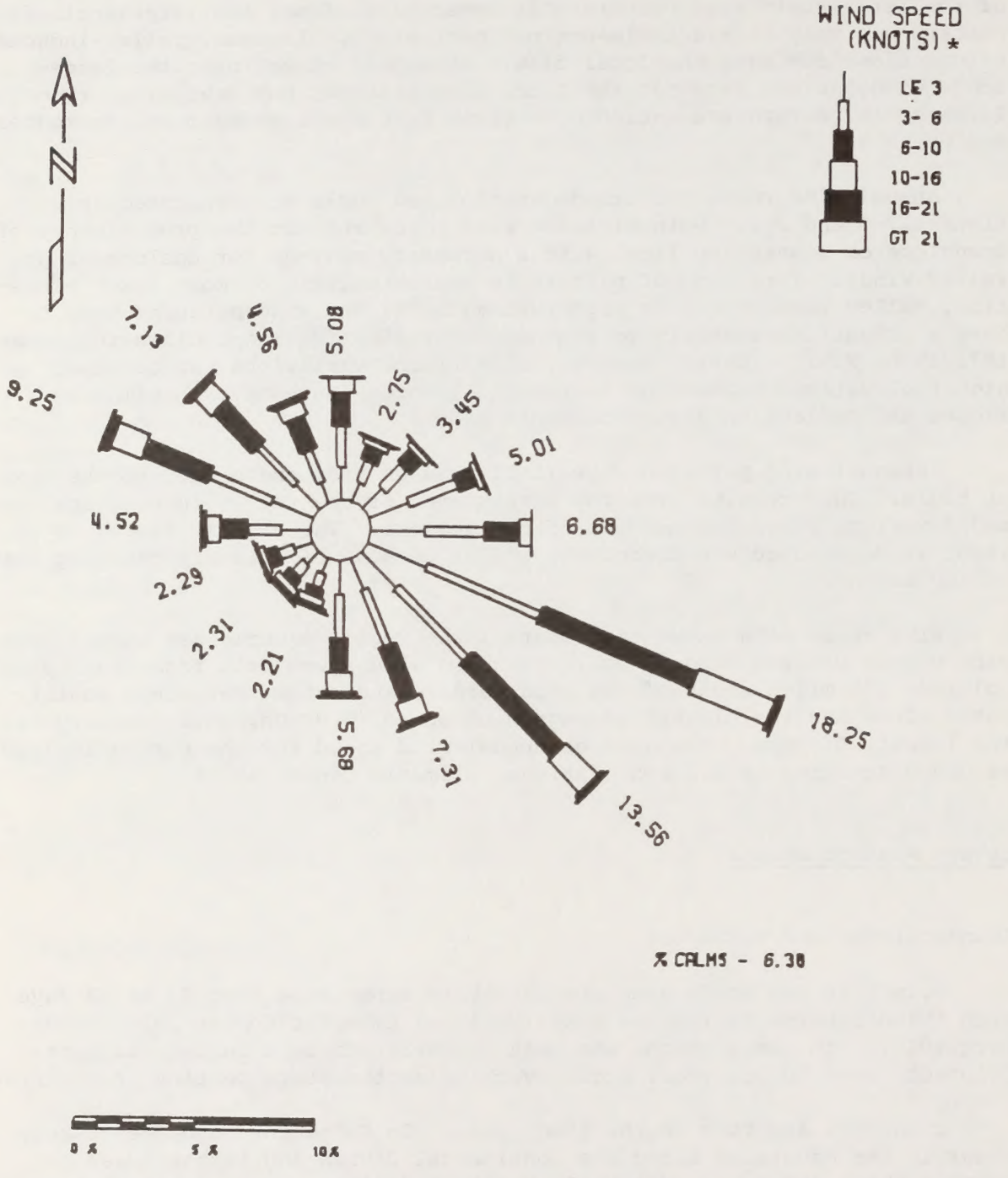


Figure 2-1.

ANNUAL WIND ROSE - GRAND JUNCTION, COLORADO, 1959-1968

Sources: National Climatic Center, 1959-1968.
National Climatic Center, 1968.

* (1 knot = 1.15 miles per hour)

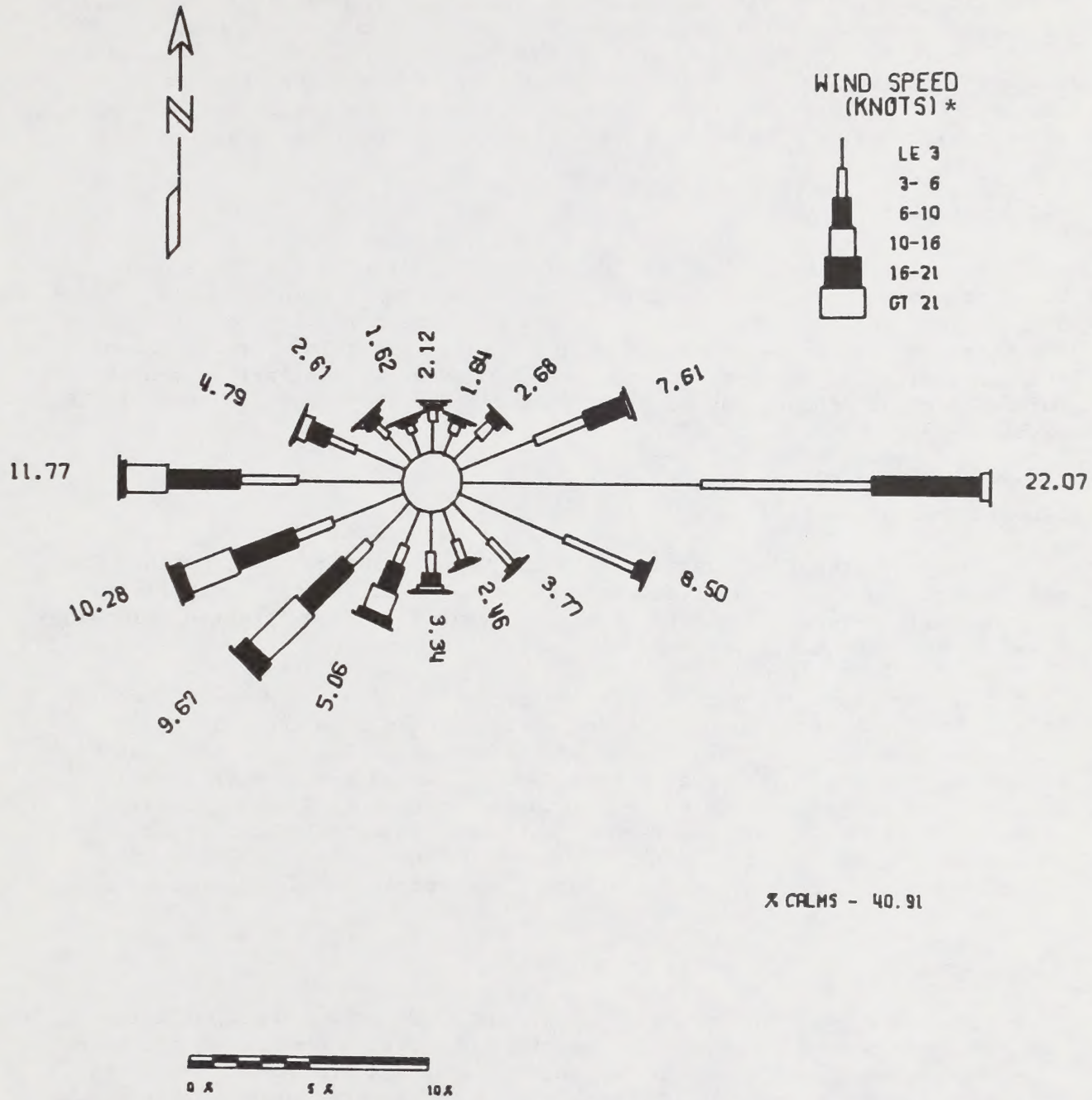


Figure 2-2.

ANNUAL WIND ROSE - EAGLE, COLORADO, 1965-1974

Sources: National Climatic Center, 1965-1974
National Climatic Center, 1968.

* (1 knot = 1.15 miles per hour)

Hailstorms

Hail in the study area is not unusual. Approximately 7 percent of the thunderstorms produce hail that reaches the ground (Flora 1956). Hail occurs most often over the extreme southeastern portion in the mountainous terrain, in the vicinity of Yampa. As many as four to six days with hail are recorded there on the average each year. The remainder of the study area averages about one hail day per year, except in the central portion where Craig, Colorado, reports slightly more than three days of hail per year.

Heavy Rainfall Events

The heaviest theoretical rainfalls for the United States have been calculated using real data as input for mathematical rainfall models. These calculations indicate that the study area has a mean recurrence interval of 100 years for 30-minute rainfalls of 1.2 inches. Therefore, rainfalls of this intensity can be expected once every 100 years. Similarly, 24-hour rainfalls of 3.0 inches can be expected once every 100 years (Hershfield 1961) (Table 2-13).

Flooding and Streamflow

The study area is situated within the Upper Colorado River Basin. The main rivers are the Green River, the Little Snake River, the Yampa River, and the White River. All of these rivers eventually flow into the Colorado River in eastern Utah.

Flooding is possible during the late spring and early summer. Most of the water that runs into the river systems comes from snowmelt at the higher elevations. The streams in the west experience snowmelt runoff before the streams in the east (Irons 1965). During a year with normal snowfall and normal springtime temperatures, no general flooding occurs, although the river levels may become quite high (National Oceanic and Atmospheric Administration 1974). However, during years with heavy snow cover or sudden spring warming (or both), widespread flooding may occur.

Blizzards

Blizzard conditions rarely occur in the study area. On high plateaus and the upper slopes of the higher mountains, blizzard conditions are more likely since wind speeds are higher and temperatures are lower. However, blizzards are more common on the high plains of eastern Colorado than in the western portions of the state. Furthermore, blizzards on the Colorado plains are less frequent and less intense than in states to the north and east (National Oceanic and Atmospheric Administration 1974).

TABLE 2-13

MAXIMUM EXPECTED RAINFALL AMOUNTS (IN INCHES) PER DURATIONS FOR SELECTED RECURRENCE INTERVALS FOR THE STUDY AREA 1/

Rainfall duration (hours)	Rainfall recurrence intervals (years)						
	1	2	5	10	25	50	100
½	0.3	0.4	0.6	0.8	1.0	1.1	1.2
1	0.4	0.5	0.8	1.0	1.2	1.4	1.5
2	0.5	0.7	1.0	1.2	1.4	1.7	1.9
3	0.6	0.8	1.1	1.3	1.5	1.8	1.9
6	0.7	0.9	1.2	1.5	1.8	2.0	2.3
12	0.8	1.1	1.5	1.7	2.1	2.4	2.7
24 (1 day)	1.0	1.2	1.7	2.0	2.4	2.7	3.0
48 (2 days)	-	1.3	1.8	2.1	2.6	3.1	3.2
96 (4 days)	-	1.6	2.1	2.3	2.9	3.2	3.5
168 (7 days)	-	1.8	2.2	2.6	3.0	3.5	3.9
240 (10 days)	-	2.0	2.6	3.0	3.2	3.7	4.0

1/ Values obtained from isopluvial analyses.

Sources: Hershfield, 1961; Miller 1964.

"Extreme Mile" Winds

In the study area, "extreme mile" winds (very strong sustained winds) can result from strong pressure gradients associated with localized severe thunderstorms or with extra-tropical cyclones (less frequently). Strong winds, although not necessarily "extreme mile" winds, most frequently occur with passages of cold fronts during the spring.

In the study area, there is a mean recurrence interval of 50 years for 80 mph winds. Winds of 90 mph have a mean recurrence interval of 100 years. Relative to other states in the Rocky Mountain Region, Colorado ranks as one of the lowest for wind destruction potential.

Pollution Dispersion Potential

General Characterization

The pollution dispersion potential for the study area is somewhat worse than the average dispersion potential for the contiguous United States. Approximately one-third of the United States has worse dispersion potential than the study area. The pollution dispersion potential is an indicator of the ability of the atmosphere to disperse or dilute air pollutants and is related to air ventilation. In general, a high pollution dispersion potential (high ventilation) is desirable, since it lowers the pollution concentrations that can be expected at the ground level.

Ventilation

Ventilation values as well as mixing heights and transport wind for the study area appear in Table 2-14. Ventilation is the product of mixing height and transport wind. A high ventilation value is indicative of good dispersion. The mixing height refers to the height above the ground below which turbulence causes the air to be well mixed. Turbulence in the lower atmosphere is produced mainly by frictional effects from the ground and objects on the ground as well as by the transfer of heat from the ground to the atmosphere on sunny days. The transport wind is the average wind speed in the mixed layer of the atmosphere between the ground and the mixing height.

Dispersion and Wind Flow in Valleys

The strongest influence on prevailing wind patterns within valleys in the study area is the orientation of the valleys. At higher elevations, the large-scale atmospheric circulation patterns are the strongest influence on prevailing winds.

Dispersion conditions in valleys are strongly affected by valley flow

TABLE 2-14

DISPERSION CONDITIONS IN THE STUDY AREA

Season	Mixing height (meters, feet)				Transport wind speed (meters/second, miles/hour)				Ventilation 1/ (meters sq./second, feet sq./second)			
	Morning		Afternoon		Morning		Afternoon		Morning		Afternoon	
Winter	320	1,050	1,100	3,600	3.5	7.8	3.8	8.5	1,120	12,060	4,180	45,000
Spring	600	1,950	3,000	9,800	5.0	11.2	6.5	14.5	3,000	32,290	19,500	209,910
Summer	320	1,050	3,800	12,500	3.9	8.7	6.0	13.4	1,250	13,460	22,800	245,430
Fall	250	800	2,100	6,900	3.8	8.5	4.7	10.5	950	10,230	9,870	106,240
Annual	370	1,200	2,500	8,200	4.0	8.9	5.2	11.6	1,480	15,930	13,000	139,940

1/ Ventilation equals mixing height times transport wind speed.

Source: Holzworth 1972.

Period of Record: 1960-1964.

patterns. Drainage flow (downslope flow) generally causes poor dispersion, since only weak mechanical mixing occurs when these stable conditions are present. The daytime upslope flow provides good dispersion within a valley. Pollutant emissions from lower elevations are carried up along the mountain slopes and enter the large-scale flow at higher elevations.

In any given valley the downslope flow generally lasts longer than the upslope flow. For this reason, the downslope flow normally dominates the annual wind pattern at the lower elevations within valleys. A similar but lesser effect is associated with the upslope flow. Furthermore, the downslope flow follows roughly the same path as the drainage of water in the valleys, whereas the upslope flow follows more complicated patterns, influenced mainly by the surface exposure to sunshine.

Figure 2-3 shows the annual wind direction frequencies (at the 30-foot level above the ground) for a weather station located within the Yampa River Valley near Hayden, Colorado. This river valley is generally oriented east-west with lower elevations in the western portions and higher elevations in the eastern portions. Downslope flow is characteritically an easterly wind (winds blowing from east to west) and this station frequently records downslope winds. Both the upslope and downslope flow regimes are more prominent with clear skies, and both are likely to be weak or absent with heavy cloud cover. Nighttime downslope flow along river drainages becomes more pronounced during the winter because of longer nights and the presence of snow cover, while the upslope flow is stronger during the summer because there is more sunshine and a lack of snow cover.

Airsheds

Valleys in the study area form airsheds where dispersion is often limited. Major airsheds are shown in Map 2-4. Dispersion is most limited in these airsheds during nights with clear skies, when downslope flow along river drainages becomes predominant. During periods of poor dispersion at night, air pollution emissions are swept into and contained within the valley basins until daytime heating causes the flow to reverse and dispersion to improve. The largest airsheds are defined by the valley basins of the Yampa, White, and Colorado Rivers. Most of the smaller airsheds drain into these basins. The areas outside of the airshed boundaries in Map 2-4 are mostly at higher elevations where large-scale weather patterns dominate the air flow and dispersion. The valley-induced upslope and downslope flows (see Dispersion and Wind Flow in Valleys) are dominant within the airsheds.

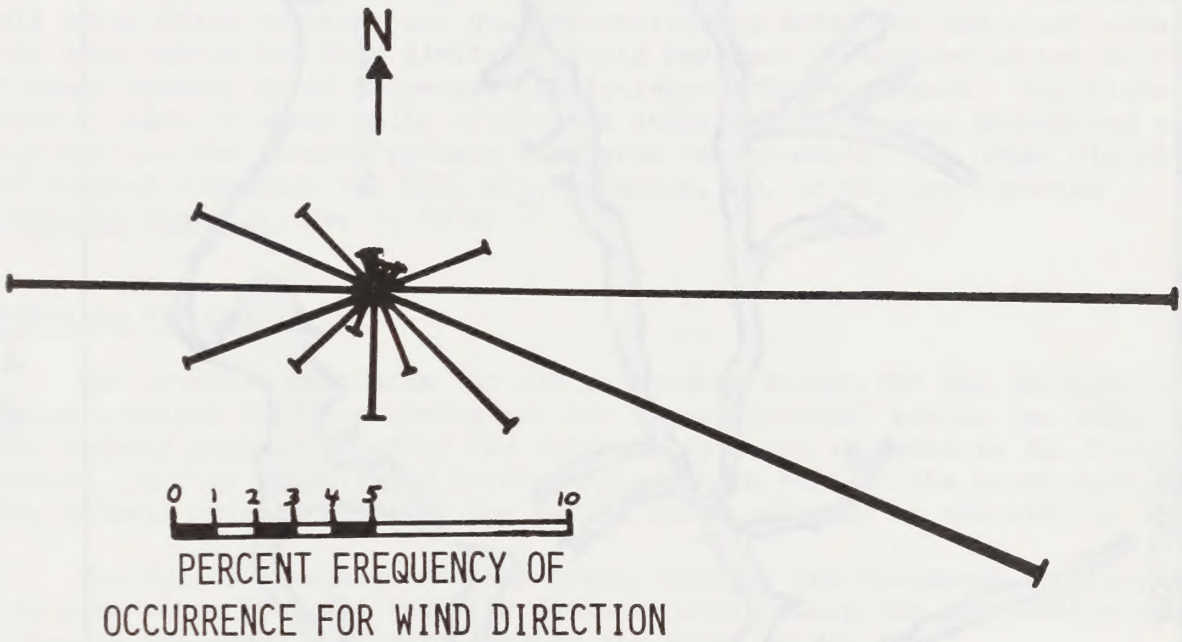
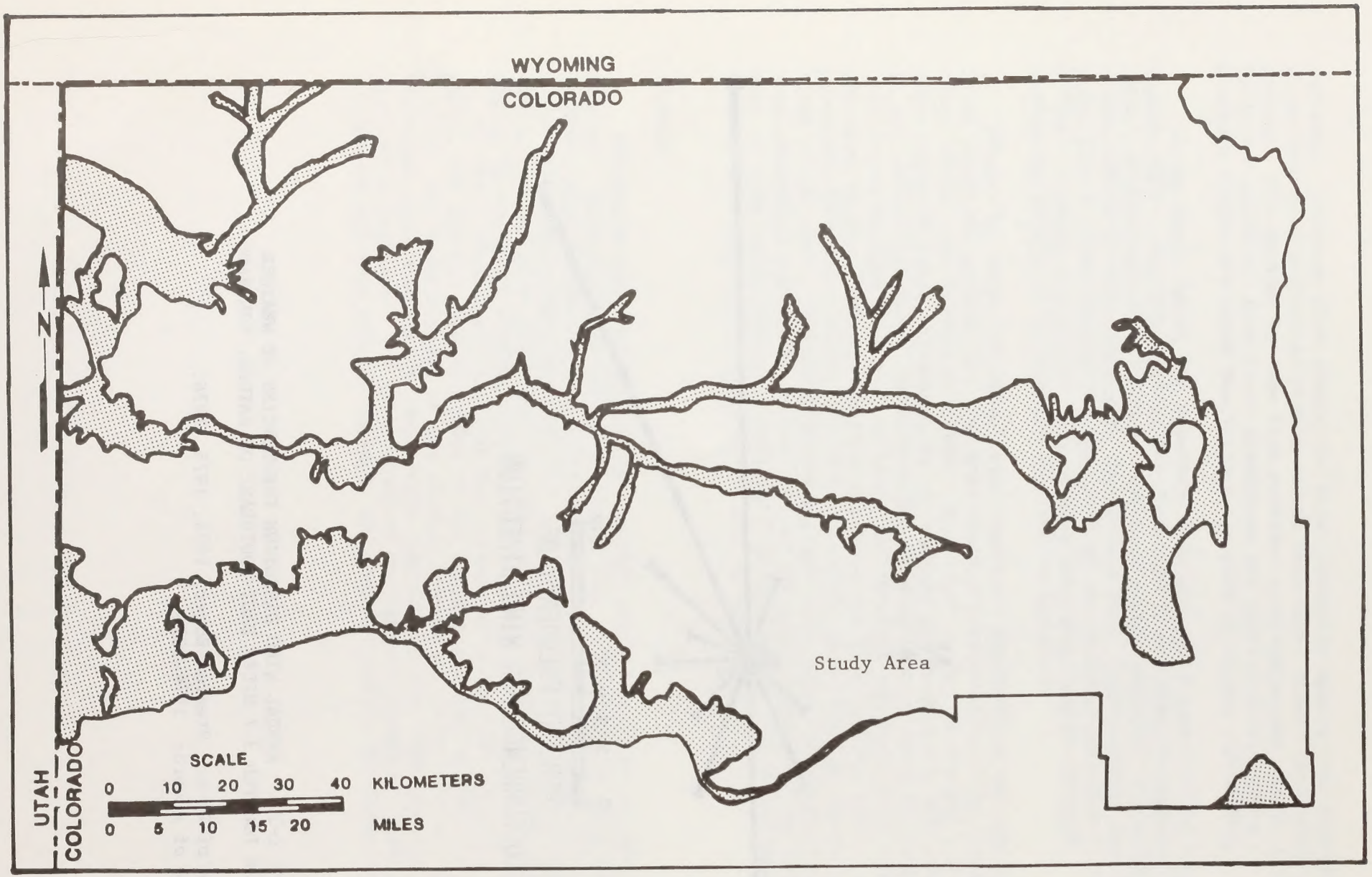


Figure 2-3. ANNUAL WIND DIRECTION FREQUENCIES AT WEATHER STATION LOCATED 3.7 MILES EAST-SOUTHEAST OF HAYDEN, COLORADO

Source of Data: Stearns-Roger, 1974, 1975, 1976.
Period of Record: 1974-1976.



Map 2-4

MAJOR AIRSHEDS (STIPPLED AREAS)
IN THE STUDY AREA

Federal and State Designations

Under the 1977 federal Clean Air Act Amendments, all areas of the country were designated as Class II except for "mandatory" Class I areas. In mandatory Class I areas, visibility cannot be impaired. There are two mandatory Class I areas in the study area. These include the northern tip of the Flat Tops Wilderness Area and the western part of the Mount Zirkel Wilderness Area. The Dinosaur National Monument is a Colorado Category I area. The eastern part of the monument falls within the study area. These areas are shown in Map 2-5. The Colorado Category II and federal Class II areas can be reclassified by the state; however, mandatory Class I and Colorado Category I areas cannot be reclassified.

As required by the Clean Air Amendments of 1977, Colorado classified all areas using existing air quality monitoring data. In the study area, the area within the city limits of Craig has been designated as not meeting primary federal total suspended particulates (TSP) standards. Rio Blanco County, part of which falls within the study area, has been designated as not meeting the federal primary standards for oxidants. No other violations of federal standards for TSP, SO_2, oxidants, CO, or NO_2 are reported (Federal Register, May 3, 1978).

Existing Air Quality

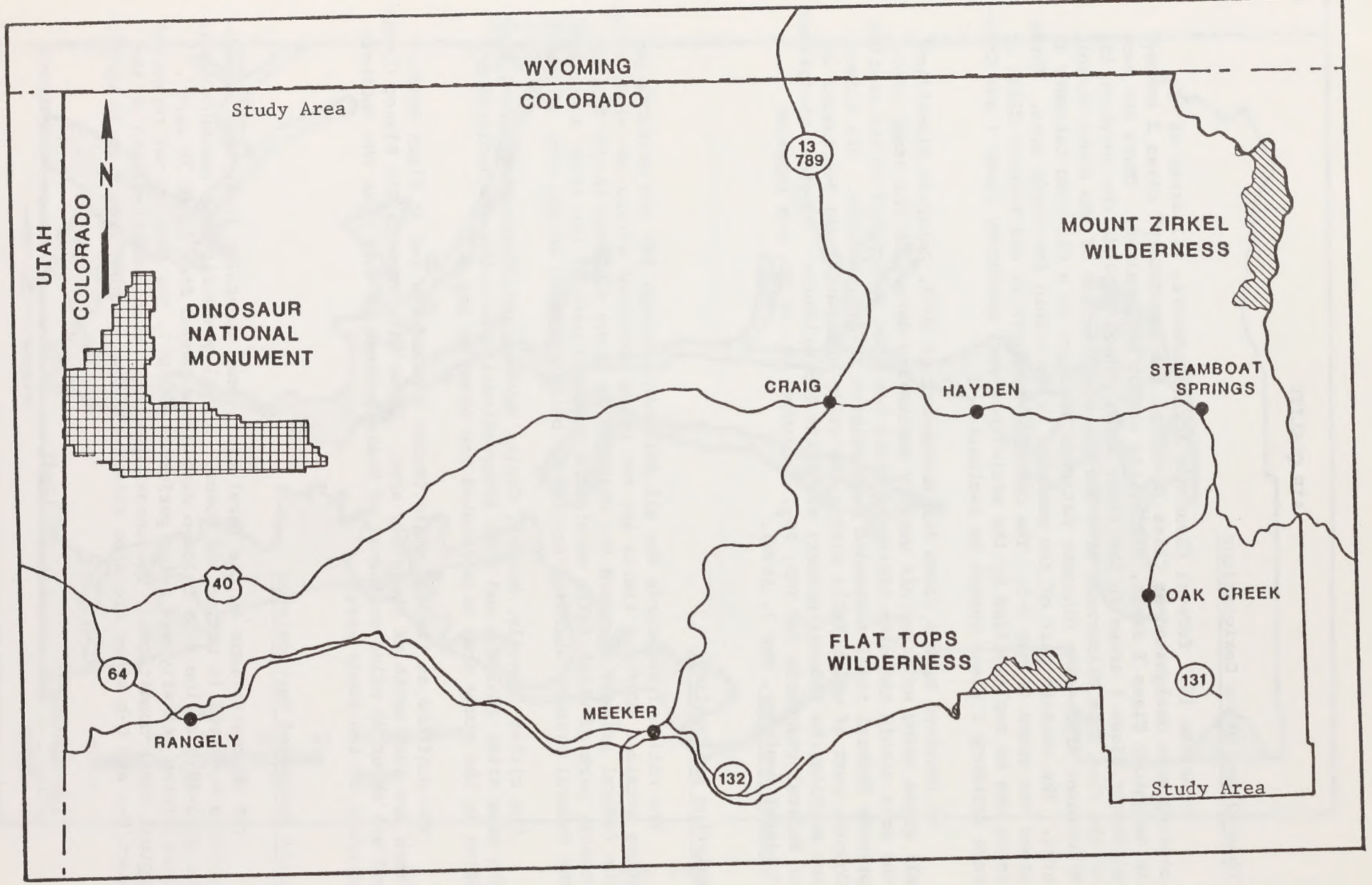
The national standards for all pollutants except TSP and oxidants are being attained (defined limits are not being exceeded) within the study area. The federal primary standard for oxidants is being violated in Rio Blanco County, part of which falls within the southern part of the study area. The federal primary standard for TSP is being violated in the city of Craig.

The cities (Rangely, Meeker, Craig, Hayden, and Steamboat Springs) and the mine sites (Colowyo and Utah International) where the air monitoring sites in the study area were located are shown on Map 2-6.

The monitors at the oil shale Tracts C-a and C-b and at Black Sulfur Creek are just south of the study area. These sites are in Rio Blanco County and are about 20 miles southwest of Meeker, which is very near the southern boundary of the study area.

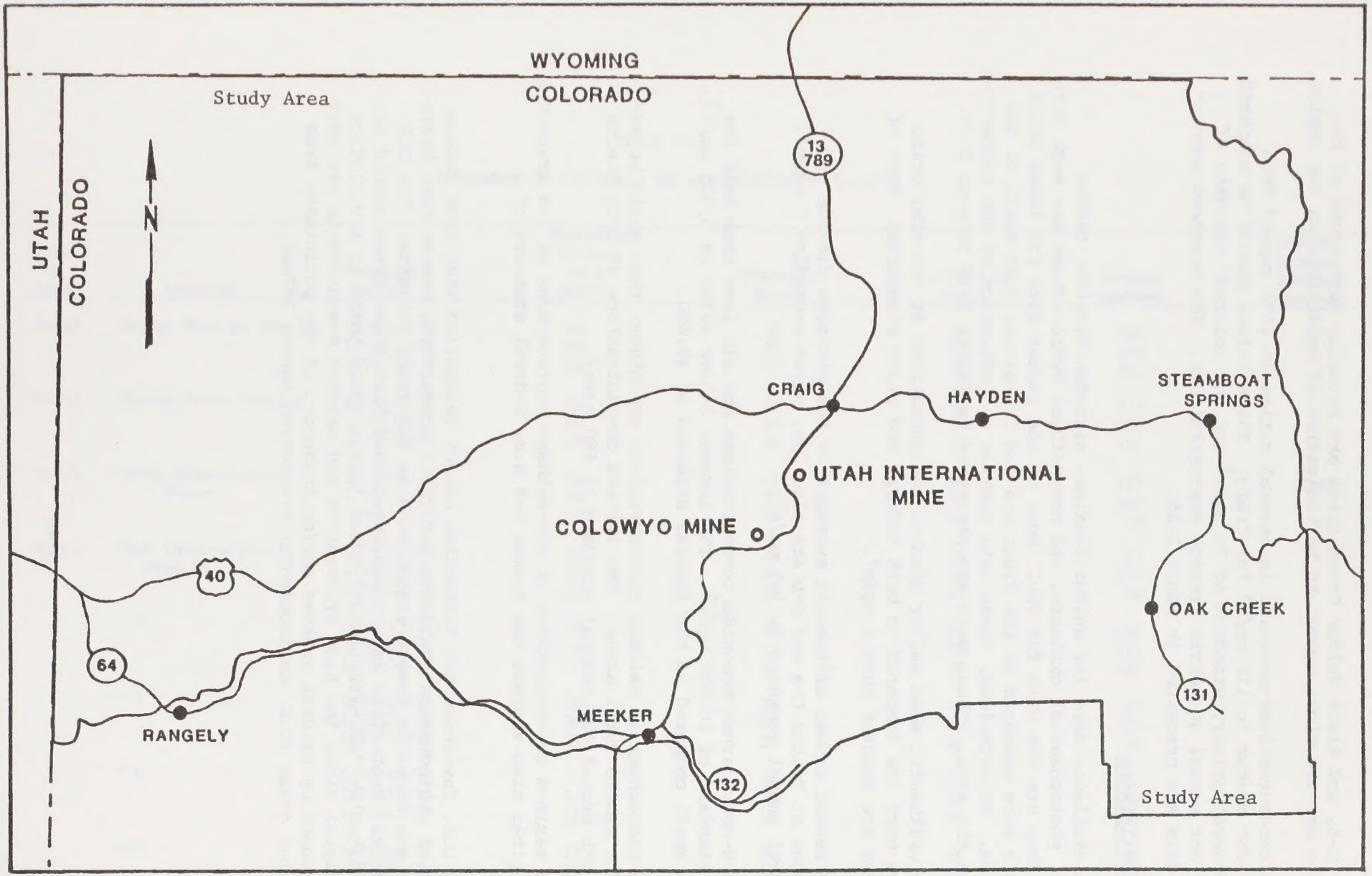
Total Suspended Particulates

TSP concentrations in the rural areas were generally lower than concentrations measured in cities and towns. Annual geometric mean concentrations for 1975-1976 at the four Colowyo mine sites ranged from 12 to 28 ug/m^3. Since mining activity was being performed in 1977, the data do not represent typical rural conditions. The annual geometric mean concentrations at the Tract C-a and C-b sites are also relatively low, ranging from 8 to 18 ug/m^3.



Map 2-5

COLORADO CATEGORY I AREAS FOR SULFUR DIOXIDE AND FEDERAL MANDATORY CLASS I AREAS IN THE STUDY AREA



Map 2-6

LOCATIONS OF AMBIENT AIR QUALITY MONITORING SITES

The C-a, C-b, and Black Sulfur Creek sites are actually just south of the study area but are close enough to be indicative of conditions in the region.

The concentrations measured in several cities in 1976 ranged from 45 ug/m^3 for Meeker to 119 ug/m^3 for Craig. These values should be compared to the federal primary standard of 75 ug/m^3 and the Colorado standard of 45 ug/m^3 for annual geometric average concentrations. The measured concentration data are presented in Table 2-15.

Gaseous Pollutants

The available data for sulfur dioxide, nitrogen dioxide, carbon monoxide, photochemical oxidants, and non-methane hydrocarbons are much more limited than are the data for TSP. Most of the recent data for these other pollutants were measured at the Tract C-a and C-b sites, just south of the study area. Nevertheless, these data provide an indication of the background levels in the area. These data are presented in Tables 2-16 through 2-20.

The arithmetic mean sulfur dioxide concentrations at the monitoring sites are very low compared to both federal and state standards. None of the values are greater than 1 ug/m^3.

The recent annual arithmetic averages of the nitrogen dioxide concentrations at Tracts C-a and C-b are also low, never exceeding 5 ug/m^3. The federal annual standard is 100 ug/m^3.

The 8-hour carbon monoxide concentrations are all less than half the federal standard of 10,000 ug/m^3. The largest 8-hour value is 5,325 ug/m^3, which is small compared to the federal standard of 40,000.

The photochemical oxidant concentrations are higher than would be expected for remote rural areas. The largest concentrations at both Tracts C-a and C-b exceed the federal standard of 160 ug/m^3.

The maximum concentrations of non-methane hydrocarbons at the Tract C-a and C-b sites also violate the 3-hour 6-9 a.m. federal standard of 160 ug/m^3.

The U.S. Environmental Protection Agency recognized that high concentrations of photochemical oxidants and their precursors, non-methane hydrocarbons, may occur in remote areas, such as the Tract C-b site. The U.S. Environmental Protection Agency has determined that these areas should not be designated as "non-attainment" areas (areas where there is a violation of standards) since the high hydrocarbon and oxidant measurements are most likely caused by natural sources and/or transport of the pollutants from major urban areas (U.S. Environmental Protection Agency 1978a).

TABLE 2-15

A SUMMARY OF MONITORED TSP CONCENTRATIONS (ug/m^3)

Type of area	Location	Sampling period	Number of 24-hour data points	Geometric mean	Arithmetic mean	24-hour maximum	Second highest 24-hour maximum
Rural	Hayden Weather Station	1/76-12/76	66	30	46	522	165
		1/75-12/75	65	21	28	228	-
		1/74-12/74	50	27	36	163	-
Rural	Hayden River Station	1/76-12/76	62	39	48	218	-
		1/75-12/75	53	29	35	106	-
		1/74-12/74	54	35	42	126	-
Rural	Craig Meteorlogical Tower	1/76-12/76	61	41	58	219	201
		1/75-12/75	42	32	54	388	-
		1/74-12/74	30	37	40	82	-
Rural	Utah International Mine P-3	1/76-12/76	41	32	36	89	-
		1/75-12/75	35	24	30	157	-
		1/74-12/74	26	38	44	96	-
	P-4	1/76-12/76	14	55	68	149	-
		1/75-12/75	33	23	52	271	-
		1/74-12/74	17	42	79	446	-
	P-5	1/76-12/76	35	21	27	59	-
		1/75-12/75	36	14	23	215	-
		1/74-12/74	27	22	26	66	-
	P-6	1/76-12/76	38	38	49	312	-
		1/75-12/75	34	26	40	158	-
		1/74-12/74	19	35	48	130	-
	P-7	1/76-12/76	17	21	35	60	-
		1/75-12/75	28	16	22	67	-
		1/74-12/74	11	20	35	120	-

TABLE 2-15 (cont.)

A SUMMARY OF MONITORED TSP CONCENTRATIONS (ug/m^3)

Type of area	Location	Sampling period	Number of 24-hour data points	Geometric mean	Arithmetic mean	24-hour maximum	Second highest 24-hour maximum
Rural	Colowyo Mine 1/						
	1	8/75-7/76	-	16	23	127	-
	2	8/75-7/76	-	28	63	1,300	-
	3	8/75-7/76	-	14	19	73	
	4	8/75-7/76	-	12	16	78	
Rural	Black Sulfur Creek	1/76-12/76	39	11	16	117	39
		1/75-12/75	-	13	19	111	-
		1/74-12/74	-	16		132	-
Rural	Tract C-a						
	1	2/76-1/77	-	8	-	81	-
		2/75-1/76	-	9	16	211	162
	2	2/76-1/77	-	9	-	57	-
		2/75-1/76	-	9	14	102	78
	3	2/76-1/77	-	12		281	-
		2/75-1/76	-	18	24	247	189
	4	2/76-1/77	-	12	-	182	-
		2/75-1/76	-	13	22	469	360
Rural	Tract C-b						
	020	11/75-10/76	-	8	9	79	55
		11/74-10/75	-	10	13	133	89
	021	11/75-10/76	-	8	9	90	59
		11/74-10/75	-	10	11	125	97

1/ The 1977 data were excluded because there were mining operations. The excluded data do not represent typical rural conditions.

TABLE 2-15 (cont.)

A SUMMARY OF MONITORED TSP CONCENTRATIONS (ug/m^3)

Type of area	Location	Sampling period	Number of 24-hour data points	Geometric mean	Arithmetic mean	24-hour maximum	Second highest 24-hour maximum
	022	11/75-10/76	-	6	7	60	50
		11/74-10/75	-	8	11	154	116
	023	11/76-8/77	-	-	-	-	-
		11/75-10/76	-	6	7	123	96
		11/74-10/75	-	11	12	171	112
	024	11/75-10/75	-	7	8	116	77
		11/74-10/75	-	8	17	178	162
City	Steamboat Springs	1/75-11/75	51	117	127	271	254
		1/75-12/75	-	121	145	407	-
		6/74-12/74	-	123	-	340	-
		1/74-6/74 2/	-	93	-	518	-
City	Craig	1/76-12/76	80	119	135	441	293
		1/75-12/75	-	80	104	322	-
		1/74-12/74	-	75	-	234	-
City	Meeker	1/76-12/76	76	45	52	190	124
		1/75-12/75	-	47	55	140	-
		1/74-12/74	-	44	-	231	-
City	Rangely	1/76-12/76	87	49	60	205	168
		1/75-12/75	-	43	54	290	-
		1/74-12/74	-	36	-	196	-
City	Hayden 3/	1/74-12/74	-	36	-	228	-

2/ Site moved in June, 1974.
3/ Site closed in 1974; reactivated October, 1977.

TABLE 2-16

A SUMMARY OF MONITORED SO_2 CONCENTRATIONS (ug/m^3)

Type of area	Location	Sampling period	Arithmetic mean	3-hour maximum	24-hour maximum
Rural	Hayden weather station	1/76-12/76	2	91	23
Rural	Tract C-a				
	1	2/76-1/77	3	-	-
		2/75-1/76	8	114	37
	2	2/76-1/77	<1	-	-
		2/75-1/76	5	178	24
	3	2/76-1/77	8	-	-
		2/75-1/76	3	50	19
Rural	Tract C-b	11/75-10/76	<1	-	-
	020	11/74-10/75	<1	32	30
	021	11/75-10/76	<1	-	-
		11/74-10/75	1	66	43
	022	11/75-10/76	<1	-	-
		11/74-10/75	<1	27	14
	023	11/75-10/76	<1	-	-
		11/74-10/75	1	88	43
	024	11/75-10/76	1	-	-
		11/74-10/75	1	78	29

TABLE 2-17

SUMMARY OF MONITORED NO_2 CONCENTRATIONS (ug/m^3)

Type of area	Location	Sampling period	Arithmetic mean	3-hour maximum	24-hour maximum
	Tract C-a				
	1	2/76-1/77	<1	-	-
		2/75-1/76	2	-	-
	3	2/76-1/77	1	-	-
		2/75-1/76	<2	-	-
	Tract C-b	11/75-10/76	5	-	-
	020	11/74-10/75	4	-	-
	023	11/75-10/76	2	-	-
		11/74-10/75	2	-	-

TABLE 2-18

A SUMMARY OF MONITORED CO CONCENTRATION (ug/m^3)

Type of area	Location	Sampling period	Arithmetic mean	3-hour maximum	24-hour maximum
Rural	Tract C-a				
	1	2/76-1/77	382	1,777	-
		2/75-1/76	895	3,766	3,585
	3	2/76-1/77	519	2,087	-
		2/75-1/76	932	5,386	4,418
	Tract C-b	11/75-10/76	605	1,689	-
	020	11/74-10/75	1,080	4,651	4,502
	023	11/75-10/76	1,352	3,539	
		11/74-10/75	1,114	2,475	-

TABLE 2-19

SUMMARY OF MONITORED PHOTOCHEMICAL OXIDANTS (ug/m^3)

Type of area	Location	Sampling period	Arithmetic mean	1-hour maximum
	Tract C-a			
	1	2/76-1/77	70	70
		2/75-1/75	66	135
	3	2/76-1/77	64	64
		2/75-1/75	60	177
	Tract C-b	11/75-10/75	53	148
	020	11/74-10/75	69	>160
	023	11/75-10/76	56	124
		11/74-10/75	68	152

TABLE 2-20

A SUMMARY OF MONITORED NON-METHANE HYDROCARBONS (ug/m^3)

Type of area	Location	Sampling period	Arithmetic mean	6-9 am 3-hour maximum
	Tract C-a			
	1	2/76-1/77	64	
		2/75-1/76	76	303
	2	2/76-1/77	45	-
		2/75-1/75	102	289
	3	2/76-1/77	13	-
		2/75-1/76	69	135
	4	2/76-1/77	37	-
		2/75-1/76	62	-
	Tract C-b			
	020	11/75-10/76	54	452
		11/74-10/75	74	708
	023	11/74-10/76	571	2,597
		11/74-10/75	131	595

Baseline Concentrations

The air quality maintenance area analyses from northwest Colorado show that the baseline (normal) TSP level in Moffat and Routt Counties is about 28 ug/m^3. This value does not reflect the influence of cities, highways, and major point sources but rather reflects the influence of dust generated by agricultural activities in the area. This baseline number was computed from the rural TSP data presented in Table 2-15, which were taken in Moffat or Routt County. All rural sites except Black Sulfur Creek and Tracts C-a and C-b are in these two counties.

The remaining rural TSP data presented in Table 2-15 were used to compute a baseline value of 10 ug/m^3 for Rio Blanco County. Both baseline values are averages of the reported geometric mean concentrations for the different sites and time periods. Since most of the sources in the study area are located in Moffat and Routt Counties, a single particulate baseline concentration of 28 ug/m^3 was selected as the standard for determining all ambient air quality impacts in the study area.

Baseline concentrations can be estimated for the other pollutants, (SO_2, NO_2, CO, photochemical oxidants, and non-methane hydrocarbons) from the data in Tables 2-16 through 2-20. These available data sets are small. They were calculated from data collected mostly at oil shale tracts C-a and C-b, which were the only gaseous pollutant monitoring data available. On this basis examination of this data, annual baselines were estimated for TSP, SO_2, NO_2, and CO of 28, 2, 2, and 860 ug/m^3, respectively. A 3-hour baseline concentration of 447 ug/m^3 for non-methane hydrocarbons was estimated.

The soil associations (soil mapping units) of the study area have been grouped into five categories at the order level of soil taxonomic classification: Alfisols, Aridisols, Entisols, Inceptisols, and Mollisols. These orders are shown for the study area on map foldout 8 in Appendix B, NWCCRES. The soil associations within each order are described in Table 2-21 as are the environmental characteristics important to soil formation and reclamation potentials. The order level is the broadest category of soil classification based on morphology, with factors of climate, topography, parent material, time, and biotic factors affecting soil formation and shaping soil properties characteristic of each order. In general, the orders of the study area can be described as follows.

Alfisols

Soils of the order Alfisol have light-colored, low organic matter surface layers, displaying translocation of clays to the lower profile without a depletion of base saturation in the surface layers. Within the study area, the Alfisols are found at elevations from 8,000 to 11,000 feet and where there is precipitation of 20+ inches, a cryic (cold) soil temperature regime, growing season of 0 to 70 days on mountain slopes, and occur predominantly on mesas under a coniferous forest. Parent material includes a variety of igneous and sedimentary rocks, tilth is poor due to lack of organic matter in the surface layers, and water is available for plant growth for at least a 3-month period each year. The reclamation potential for soils of this order are rated poor due to excessive slopes, coarse fragments, shallowness, and short growing season. They occur primarily in Routt County, with minor areas in Moffat and Rio Blanco Counties, totaling 287,784 acres (7 percent of the total area of the three counties).

Aridisols

The most significant properties of this order are lack of water available to plants for extended periods, surface layers light colored and low in organic matter, and accumulations of clay and carbonates, which may occur in the profile due to less intensive leaching in the drier climate. These soils can be found in areas of elevation ranging from 5,000 to 9,000 feet, where there is precipitation of 8 to 20 inches depending on elevation, mesic and frigid soil temperature regimes, and a growing season of 60 to 140 days. These areas are found on mesas, uplands, valley bottoms, terraces, and foothills. Parent material includes sedimentary rocks of sandstone, shales, mudstones, and siltstones altered by wind and water. The areas are often sparsely vegetated with sagebrush, grasses, greasewood,

TABLE 2-21

ENVIRONMENTAL CHARACTERISTICS IMPORTANT TO SOIL FORMATION AND RECLAMATION

Soil map symbol	Textural family 1/	M.A.P. (inches) 2/	Soil temp. regime	Growing season (days)	Elevation (1000s of feet)	Nat. Veg. 3/	Land-form 4/	Sediment yield 5/	Reclamation potential 6/	Present use 7/
21	clayey-loamy 8/	15-20	frigid	100-120	6.5-9	m-b	up-vy	0.2-1.0	g	DC,IC,RE
35	loamy	12-15	frigid	60-90	6.5-8	s	up	0.2-1.0	g	UD,RC,WE
59	loamy	12-20	frigid	90	7-8.5	m-s	ms	0.1-0.2	f-p 9/	RE,IC,WE
62	clayey	15-20	frigid	90-110	6.5-8	m-b	up	0.2-0.5	g	RC,WS

1/ Assume well-drained soil material (10-40 inch layer).
2/ M.A.P. = mean annual precipitation.
3/ a, aspen; b, bottom; c, conifer; g, greasewood; j, juniper; m, mountain shrub; p, pinyon; r, grass; s, sagebrush; t, saltbrush; u, bitterbrush.
4/ be, bench; br, break; cy, canyon; fh, foothill; fn, fan; fp, floodplain; ma, mesa; ms, mountain slope; mt, mountain top; te, terrace; up, upland; vy, valley.
5/ Acre-feet per square miles per year. (Reference: Colorado Land Use Commission, 1974).
6/ g, good; f, fair; p, poor.
7/ DC, dry cropland; IC, irrigated cropland; PE, pasture; RC, recreation; RE, range; UD, urban development & subdivision; WE, wildlife; WL, woodland; WS, watershed.
8/ Texture has > 35 percent by weight of clay, < 35 percent by volume of rock fragments.
9/ Excess slope.

or pinyon-juniper. The reclamation potentials are rated poor to good depending upon droughtiness, shallowness, clayey textures, and excessive slopes. The majority of the Aridisols can be found in Moffat County, with the remainder in Rio Blanco and Routt Counties. Total land surface includes 779,188 acres, about 19 percent of the total.

Entisols

Entisols are those soils that show little or no evidence of profile development. Accumulation of organic matter may occur in the top few inches as well as slight loss of carbonates from the surface layer. The soils are dominated by mineral soil material associated with recent deposits of either wind or water or associated with conditions where rates of erosion exceed rates of deposition and profile development. The soils occur in areas ranging from 5,000 to 8,000 feet in elevation, having precipitation of 8 to 18 inches, mesic and frigid soil temperature regimes, a growing season of 90 to 140 days, a landscape position of alluvial fans, floodplains, uplands, mesas, breaks, and canyons, and a vegetative type varying from sagebrush, bitterbrush, saltbrush, to pinyon-juniper stands. Parent material consists mainly of sedimentary rocks. Reclamation potentials range from poor to good depending upon excessive slopes, excessive salts, semi-droughtiness, or shallowness. Total surface coverage is about 2,132,584 acres (51 percent of two counties' areas), primarily in Moffat County with a minor portion in Rio Blanco County.

Inceptisols

Inceptisols are young soils having altered surface layers with loss of bases, iron, and aluminum, but retaining some weatherable minerals. The profile does not represent extreme weathering but is more developed than Entisols. Another characteristic typical to the order is lack of accumulated horizons of clay and iron and aluminum oxides. These soils in the study area range in elevation from 11,000 to 12,000 feet, have precipitation of 20+ inches, a pergelic soil temperature regime, a growing season of 30 days, and have developed under coniferous forest and other alpine vegetation on mountain tops. Reclamation potential is rated poor due to shallowness, excessive slopes, coarse fragments, and short growing season. These soils are found only in the higher elevations of Routt County, covering 21,720 acres (1 percent of the county's total area).

Mollisols

Soils classified as Mollisols have dark-colored organic and base enriched surface layers varying from 7 to 20+ inches thick. The enriched surface layers are indicators of increased soil forming processes associated with the higher precipitation zone of 15 to 20+ inches. There are more silicate clays in the subsoil and

carbonates and salts are translocated to greater depths than in Aridisols. These soils occur at elevations of 6,500 to 9,000 feet, have frigid and cryic soil temperature regimes, and occur where there is a growing season of 30 to 110 days and a landscape position on mountain slopes, benches, and uplands. The vegetation may vary from sagebrush, mountain shrubs, saltbrush, forbs, to grasses. The soils generally exhibit a good reclamation potential due to the good surface layer qualities and sufficient moisture for good plant growth. However, the reclamation potential rating may be lower in areas with high coarse fragment content, excessive slopes, droughtiness, clayey textures, shallowness, and short growing season. Mollisols cover an area of 921,724 acres or about 22 percent of the total study area.

An overall analysis shows that a significant amount of the report area soils are classified as Entisols (51%), Mollisols (22%), and Aridisols (19%). Insignificant amounts of Inceptisols (1%) and Alfisols (7%) can be found in the higher elevations of the report area. Reclamation potentials are quite variable, ranging from poor to good, depending upon excessive slopes, shallowness, high coarse fragment content, high clay textures, excessive salts, droughtiness, and short growing season. To a certain extent, referring to the soil associations (family level of soil taxonomy) in Appendix D, NWCCRES, will complement the broad view expressed by the discussion of soil orders. Presently, the USDA, Soil Conservation Service is conducting a detailed soil survey within the study area boundaries. Initial soil survey studies have revealed considerable variations of soil physical and chemical characteristics beyond those discussed by soil associations. Before any specific coal development is initiated, a detailed soil survey would need to be consulted to determine soil suitability for reclamation.

Descriptions of each type and locations of each type are found on map foldout 9 in Appendix B of the NWCCRES. For a more detailed description of each vegetative type, refer to NWCCRES Regional Chapter 2 (Description of environment, Terrestrial Flora), pages II-49 through II-57.

Nine primary and two secondary vegetative types are found in northwest Colorado. The primary types are grassland, sagebrush, mountain shrub, conifer, barren, pinyon-juniper, saltbush, greasewood, and cropland; the secondary types are aspen and river-bottom (see Map 9, Appendix B, NWCCRES). Type designations are those used by the BLM as described in BLM Manuals 9160-9162.

The vegetation of this region is a complex mosaic where soils, climate, aspect, altitude, grazing, and general land use history are the controlling factors in plant distribution. Moisture is most often the dominant limiting factor for the distribution of vegetation on the western slope of the Rocky Mountains (James and Marr 1966).

At elevations of 5,000-7,000 feet, the mountain shrub type develops where snow collects and lies late, or where moisture is adequate throughout spring and early summer. Progressing toward the drier lower end of the scale, it is evident that on deep well-drained soils sagebrush communities dominate all locations where moisture limits other vegetative types.

Pinyon-juniper type is located in areas where precipitation is similar to sagebrush type, but soils are very shallow or nearly non-existent.

Conifer type is marginal, and usually occurs in areas of highest elevation, coolest soils and highest annual precipitation.

Aspen types occur in areas where soils are well-developed and soil moisture conditions are good; it is often a transition zone between the mountain shrub and conifer types.

Saltbush and greasewood types are found in the areas of the region with lowest precipitation and elevation. They occur where the soils are saline-alkaline, poorly drained, and often underdeveloped. Greasewood type dominates where soils are the most saline-alkaline and are most poorly drained.

The grasslands occur on sites that range from deep soil, wet mountain meadows to dry, rocky hillsides. Grassland types of the region have deteriorated much and have become increasingly less important to the biological system of the area. Some areas that were formerly grassland types have been converted to sagebrush by historic cattle over-grazing.

Barren areas are primarily Rock Outcrops, areas of bentonite clay, and areas where very little soil has developed because annual precipitation is very low.

The following table (Table 2-22) is a percentage and acreage breakdown by vegetative type for the study area. Sage, mountain shrub, and pinjon-juniper are the major vegetative types affected in the study area.

Threatened and Endangered Species

Vegetation has not been studied in sufficient depth to determine locations of threatened or endangered species within the study area.

TABLE 2-22

VEGETATION TYPES FOR STUDY AREA

Vegetative type 1/	Percentage	Acres
Sage	49.7	2,148,284
Mountain shrub	14.7	633,600
Pinyon-juniper	26.0	1,122,603
River bottom	0.5	21,848
Aspen	3.8	166,444
Cropland	3.8	166,444
Conifer	1.1	48,860
Barren	0.3	13,109
	Total	4,321,192 2/

1/ Grassland, greasewood, and saltbrush are excluded because they are an insignificant percentage of the total vegetation affected.

2/ Excludes National Forest lands, which will not be affected by mining.

Wildlife

Terrestrial Fauna

The wildlife of northwestern Colorado form a diverse matrix of mammals, birds, amphibians, reptiles, and insects. Soils, vegetation, climate and other environmental factors influence the distribution, composition, and population structure of the fauna within any given area; these components must be understood before a meaningful analysis of the fauna can be undertaken.

While some animals may be tied closely to a particular plant community, vegetative type, or soil association, others range more widely and may be found in a variety of ecosystems, depending on the time of year.

Generally, ecological information is limited for the majority of the wildlife species found in the study area. More information is available for species of higher recreational and/or economic value to man than for those species that lack these values.

A few of the important game species in the area as well as the threatened and endangered species expected to be found will be mentioned here. The Terrestrial Fauna section of Chapter II in the NWCCRES contains more detailed information on the habitat requirements and general characteristics of the wildlife species found in this region and Appendix D of the NWCCRES provides a complete list of species and their associated habitats.

Six of the ten species classified by the Colorado Division of Wildlife (DOW) as big game can be found in the study area. Cougar (Felis concolor) and black bear (Ursus americanus) can be found in specific areas of the region. High densities of these species do not occur due to their solitary and wandering nature. Black bear are omnivorous, feeding on berries and vegetation as well as on small rodents and carrion. Mule deer are the main food source for cougars in this area.

The four remaining big game species are herbivorous and should be considered primary consumers. Some animals, such as mule deer (Odocoileus hemionus) are primarily browsers while some others (e.g., the elk) utilize grass and forbs to a greater degree.

Of these, only the mule deer (Odocoileus hemionus) are distributed over the entire region. Elk (Cervus canadensis) and pronghorn antelope (Antilocapra americana) are commonly seen in specific areas of the region, some of which are critical habitat because they are deer fawning and elk calving grounds and therefore extremely important to the survival of these species. These critical habitat areas are

sites used traditionally because of vegetation and nearness to migration routes. The exact distribution of the white-tail deer (Odocoileus virginianus) is not known; some individuals have been sighted, as reported in Ecology Consultants, Inc., Yampa Valley Analysis (1972).

Components of the winter range are generally recognized as being the limiting factors for these species. Severe winter weather and the quantity and quality of food of the winter range normally limit the carrying capacity of a range.

The critical winter range is the single most important factor controlling the populations of mule deer, elk, and antelope. Animals are completely dependent on critical winter range for survival during times of highest stress due to snow and cold, which reduce food and shelter.

Sage grouse is the main upland game bird in the study area, being hunted throughout the coal resource area. The strutting grounds for this species are scattered throughout the region and are traditional use areas and therefore considered critical for its survival.

Mule deer, elk, antelope, and sage grouse are hunted extensively within the study area.

Threatened and Endangered Species

Six species of endangered wildlife are known or believed to inhabit the study area. Four of the species are on the U.S. Department of the Interior's list of endangered fauna. These are the American peregrine falcon (Falco peregrinus), the black-footed ferret (Mustela nigripes), the whooping crane (Grus americana), and the bald eagle (Haliacetus leucoephalus). The other two, the river otter (Lutra canadensis) and the greater sandhill crane (Grus canadensis tabida) are on the State of Colorado's endangered fauna list.

Peregrine falcons (Falco peregrinus) are occasionally sighted within the study area, but not on a regular basis. Although there is the possibility that this species nests in northwestern Colorado, no nests have been located within the study area, and only migration and hunting activities have been noted.

Several recordings of black-footed ferret (Mustela nigripes) have been made in Moffat and Rio Blanco Counties in the past years. The last known sighting of the black-footed ferret was in 1906 by Felger. A 1977 BLM internal report for the Craig District indicated there was no evidence of black-footed ferrets but there were hundreds of acres of possible habitat. Black-footed ferrets are generally found in prairie dog towns, prairie dogs being their primary source of food. "Most authors are in agreement the M. nigripes never has been common in Colorado" (Armstrong 1972).

The U.S. Fish and Wildlife service is attempting to establish a new population of the extremely rare and endangered whooping crane (Grus americana), by using greater sandhill cranes as foster parents. The population of greater sandhill cranes involved in this restoration effort migrates through northwestern Colorado; one young whooping crane has been reported in the Piceance Basin, just south of the study area.

The bald eagle (Haliacetus leucoephalus) was placed on the U.S. Department of the Interior's list of endangered fauna on February 14, 1978. Bald eagles can be found along open water throughout the region during the winter. Main winter concentration areas occur along the White, Yampa, Williams Fork, and Little Snake Rivers. The numbers of eagles wintering in the area vary from year to year depending mainly on the harshness of the weather in this area and further north. It is possible that a few pairs remain in the region to nest although most migrate north in the spring There is probably one pair that nest along the Little Snake River.

The bald eagle winters near open water and will range 30-40 miles to feed. They eat fish, water fowl and some road kills.

Winter concentration areas are Lilly Park, confluence of Little Snake River and Yampa River and White River near Agency Park and four miles west of Piceance Creek. They prefer riparian type habitat, river bottoms, and cottonwoods with large roosting trees.

The range of the river otter (Lutra canadensis), as described by D. M. Armstrong (1972), indicates that this species is found in Moffat County along Little Snake River, and Yampa River in Yampa Canyon. In Rio Blanco County, there is a record of a specimen in the White River Valley. These are past records, and there is some doubt as to the continued existence of this species in the region. "I doubt that the otter now exists in Colorado, save perhaps as occasional wandering individuals" (Armstrong 1972). River otters are sociable animals and often two or more otters are seen together. River otters' principal food is made up of a variety of animal matter; fish, invertebrates, amphibians, reptiles, birds, and small mammals may be taken, with fish making up a major portion of the diet.

The greater sandhill crane (Grus canadensis tabida) has been put on the State of Colorado's Endangered Species List. The birds found in the study area are the only significant nesting population known for Colorado.

The sandhills are primarily vegetarians although some animal matter is taken, such as insects, frogs, snails, fish, and small rodents. A wide range of plant species is taken, including both marsh plants and domesticated plants, such as wheat.

Domestic Fauna

The number of animals and class of livestock in the area in any one year is dependent on market and/or forage conditions. Many livestock operations have been shifting from sheep to cattle in recent years for economic reasons.

The major classes of livestock that utilize this region are cattle (Bos sp.) and domestic sheep (Ovis sp.); there are approximately 112,500 cattle and 200,000 sheep within the area. Of this number, about 38,700 cattle and 200,000 sheep use public lands during some portion of the year. Some horses (Equus sp.), domestic as well as wild and free-roaming, are also found within the region. Population estimates of domestic horses indicate a total population of about 500. Map foldout 16 in Appendix B of the NWCCRES indicates the major classes of livestock and general seasons of use in northwestern Colorado.

Most operations rely on native range to winter livestock. Imported protein and vitamins are used to supplement the locally-grown hay and native forage. In many cases, hay is saved and used only during critical winter periods as prices in the market reach premium levels; winter forage is therefore a critical limiting factor to the livestock within the study area.

Competition may exist among domestic and wild animals for food, water, cover, or living space. Any action will alter the ecological balance to favor one species to the detriment of another: disturbances of sagebrush stands may provide suitable sharptail grouse habitat at the expense of the sage grouse (Centrocercus urophasianus) disturbances of a pinyon-juniper stand may favor mule deer at the expense of pinyon jays (Gymnorhinus cyanocephalus) and bushtits (Psaltriparus minimus).

Aquatic Biology

The eastern half of the study area has both cold and warm water habitat for fish. The main fishery in the region is the blue-ribbon trout fishery. The areas around Steamboat Springs, Hayden, Oak Creek, Yampa and Hahn's Peak are the major blue-ribbon trout fishing areas. Except for the Williams Fork River, which is considered a blue-ribbon trout fishery, the area east of State Highway 13 between the Wyoming border and Meeker and west of the Routt National Forest are fair-to-good trout fishing areas. Rainbow trout are caught in both lakes and streams and make up over 78 percent of the creel. Brook trout make up 12 percent with the following species caught in descending order: cut-throat trout, kokanee, brown trout, white fish, and mackinaw. These species are mainly in the upper reaches of the Yampa and White Rivers and their tributaries. They are also the only species caught in national forest areas. The western half of the study area has mainly warm water fisheries. Warm water fishing occurs mainly on the Yampa and White Rivers. From Maybell, Colorado, to the Utah border on the Yampa and from Rangely, Colorado, to the Utah border on the White River are the major fishing areas. Species caught include: bullhead (20 percent), channel catfish (17 percent), green sunfish (12 percent), crayfish (11 percent), suckers (10 percent), carp (6 percent), largemouth bass (6 percent), crappie (4 percent), smallmouth bass (3 percent), yellow perch (2 percent), walleye pike (2 percent), northern pike (1 percent), bluegill (1 percent), and others (5 percent). The regional analysis in the NWCCRES indicates the general distribution of the species and other pertinent data. Section 5 of Appendix A contains an addendum to the species listed in the NWCCRES.

Threatened and Endangered Species

The regional analysis in the NWCCRES gives a detailed analysis of endangered species. Portions of the White and Yampa Rivers provide suitable habitat for the Humpback chub (Gila cypha) and the Colorado River squawfish (Ptychocheilus lucius). The segment of the Yampa River from its confluence with Milk Creek to the Green River is now listed as critical habitat for the Colorado River squawfish and its protection is imperative to the survival of the species. Both species are on the U.S. List of Endangered Fauna and the Colorado List of Endangered Species. The Yampa and White Rivers also provide suitable habitat for the humpback sucker (Xyraucher texanus) and the bonytail chub (Gila elegans). The former is on the Colorado List of Threatened Species and the latter is on the Colorado List of Endangered Species.

Archeological Resources

The prehistoric and historic natives of the region were hunters and gatherers. In other regions, archeologists have found campsites of hunting and gathering people along the boundary between two ecosystems and additional evidence of their lifeway further within the two different environments. In the study area, corresponding occupation and exploitation patterns are found by archeologists. Even the Fremont people, who practiced horticulture near the Colorado-Utah state line, relied on gathering and hunting for food and non-food products. Survey and excavation have been concentrated in Dinosaur National Monument. Here the Fremont culture has been documented and older sites similar to those identified as the Desert Culture and the Plains Archaic were also found.

Archeological survey and excavation in the rest of the study area have been conducted in response to contemporary development, primarily of federally-owned mineral resources, as required by federal law. Other surveys have been conducted for two Masters theses, timber sales, chainings, a wild horse roundup compound, resolution of trespass on federal land, the municipal expansion of Rangely, and the evaluation of the proposed Skull Creek National Environmental Area located in southwest Moffat County. Adjacent to the study area, a sample survey has been completed in Piceance Basin and Class III (100 percent) surveys have been made in Canyon Pintado National Historic District and for the Savery Pot Hook Reservoir area.

Within the study area, spatial distribution of cultures and people is in the descriptive stage. A regional chronology has not been formulated and data from selected dated sites in Utah and Wyoming have been used to suggest the sequence of occupation in this part of the Western Slope. Early Plains influences and probable occupation is suggested by isolated finds of Clovis and Folsom points in and near the study area. These may date during a period of approximately 10,000 to 13,000 years ago. There may have been a cultural gap within the region during the Altithermal, a hypothesized post glacial climatic period warmer and drier than the present. Only additional investigation will establish whether occupation occurred from approximately 5,000 to 8,000 years ago. The Desert Culture from the Great Basin and the Plains Archaic culture from the Northwestern Plains filtered into the region near the end of the Altithermal. Whether the Desert Culture was replaced by or became the Fremont culture has not really been resolved. The Plains Archaic culture may have continued in Routt and the eastern part of Moffat counties while the Fremont culture became established in Rio Blanco and the western part of Moffat counties about A.D. 900. After the end of the Fremont culture, around A.D. 1200, hunting and gathering continued to historic times throughout the region.

Within the three-county area, recorded site types include open lithic sites, open camp sites, rock shelters, dry laid masonry structures or ruins, wet laid masonry structures or ruins, and rock art. Usually it is difficult to determine exact cultural affiliation during an initial survey. Diagnostic artifacts (time markers) and other datable material may be removed from sites during casual surface collection or uncontrolled digging. As of February 1, 1978, there were 348 open lithic sites, 222 campsites, 47 rockshelters, 6 dry laid structure sites, 19 wet laid structure sites, and 72 rock art sites. Twenty-one sites don't belong in the categories above and thirteen sites each include two different kinds of sites. Of these 748 sites, 81 percent are on federally controlled land, 14 percent are on private surface, and 5 percent are on state land. Twenty-three percent are in good to excellent condition, 24 percent have been obviously vandalized or disturbed, and 3 percent have been virtually destroyed by wildlife, agricultural and ranching practices, vandalism, uncontrolled digging, and surface collecting. Some sites may not have been destroyed but may have been so completely surface collected that they have lost their scientific potential. In addition, data from 350 sites are still being analyzed and reports are forthcoming.

Surveys have been initiated primarily by contemporary development and probably do not reflect prehistoric occupation and utilization within the region. Map foldout 14 (Appendix B, NWCCRES) cannot be used as the basis of predictive statements about patterns and densities of archeological resources because it does not show the acreage actually surveyed nor the density of sites within the area. In addition, there is no differentation between the areas not surveyed and areas shown to have a low site density.

Other factors have and will skew the recordation of sites. Natural and man-induced erosion have already removed sites. Commercial, industrial, agricultural, and ranching activities have obliterated sites. Natural erosional processes have buried sites.

Tables 1 and 2 in Appendix A, Section 3, summarize consultation with academic institutions and museums.

Within the study area, no archeological resources are presently on the National Register of Historic Places (NRHP).

In surveys conducted prior to and during the preparation period of the Northwest Supplemental Report, 37 sites have been recommended for nomination to the National Register. These sites have been recommended for nomination to assure that research can be conducted to describe and analyze prehistoric utilization of local and areal ecosystems and, if possible, identify cultural affiliation. Not all sites are located on federal land and those which are not must be nominated by the Colorado State Historic Preservation Officer. Those sites of NRHP quality to be involved in low-, mid-, or high-level production are described in Table 2-23.

Adjacent to the study area, there are four sites on the National Register of Historic Places. They are described by location from west

TABLE 2-23

SITES ON OR RECOMMENDED FOR NOMINATION TO THE NATIONAL REGISTER OF HISTORIC PLACES
WHICH COULD BE INVOLVED IN COAL PRODUCTION

Site designation and name	NRHP 1/ status	Type	Condition	Significance	Surface ownership	Level of coal production which effected resource
5RB53, Duck Creek Wickiup Village	On NRHP	Wickiup village	Good	State, local	BLM	High-level
5RB344, Fremont Lookout Fortification	On NRHP	Rock structure	Good, eroding	State, local	BLM	High-level
5RB485, Carrot Men Pictographs	On NRHP	Rock art	Good, vandalized	State, local	BLM	High-level
Canyon Pintado National Historic District	On NRHP	District of prehistoric and historic Indian rock art, stone structures, open camps and rock shelters. 51 sites are recorded by earlier surveys	Fair, disturbance from erosion, cattle grazing and natural gas and oil development	National, state, local	BLM	High-level
5MF435	Recommended for nomination	Rockshelter with rock shelter	Good	State, local	BLM	Low-level, mid-level high-level
5MF444	Recommended for nomination	Open camp	Good, some disturbance	State, local	Private, State of Colorado	Low-level, mid-level
5MF680	Recommended for nomination	Open lithic	Good	State, local	Private	Low-level, mid-level high-level
5RT18	Recommended for nomination	Open camp	Good	State, local	Private	High-level
5RT30	Recommended for nomination	Open camp	Fair, partly cultivated	State, local	Private	Mid-level, high-level
5RT32	Recommended for nomination	Open camp	Fair, some disturbance	Local	Private	Low-level, mid-level high-level

1/ National Register of Historic Places

to east along the southern border of the study area.

The Carrot Men site (5RB 485) is a campsite with a panel of pictographs and a panel of petroglyphs. The rock art is of the Fremont style and the camp is considered to be Fremont as well.

Fremont Lookout Fortification (5RB 344) was nominated as the only example of a Fremont defensive structure in Colorado.

Canyon Pintado National Historic District has both prehistoric and historic importance. The most noticeable feature is the rock art by Fremont and Ute Indians which has both aesthetic and scientific value. In the journal of the Escalante-Dominguez Expedition, a report of seeing the rock art and naming the location Canyon Pintado was made. The Historic District also contains occupation sites, rock shelters and open camps, and wet laid masonry sites.

Duck Creek Wickiup Village (5RB 53) is a historic Ute campsite of at least eleven wickiups. At the time it was nominated to the NRHP it was the largest known wickiup village in Colorado.

All four NRHP sites are on federally controlled land and under the jurisdiction of BLM. Because access is unrestricted and regulations are difficult to enforce, the sites are subjected to surface collection, uncontrolled digging, vandalism, and damage resulting from stock grazing in allotments or during trespass. Canyon Pintado National Historic District and the Fremont Lookout Fortification site are within an active oil and gas area. All NRHP sites are in areas of extensive and continual water erosion.

Within the time frame of 1980 to 1990, 37 to 45 archeological resources are presently recorded in areas which may be involved in coal production, including four to six sites eligible to NRHP. During future surveys both in coal development areas and in the study area generally, the number of sites recorded and number of resources eligible to NRHP would increase.

The significance of resources must be considered for the data they provide to prehistoric and historic reconstruction of geographical regions larger than just the study area. The recorded sites affected by possible new federal coal development are more significant than their apparent proportion to the total recorded resources. Six sites located in a parkland setting are continually crucial in on-going research. Two sites eligible to NRHP and some of the other sites in the study area may contain information about adaptations of the Plains Archaic in these parklands and their chronological relationships with sites containing similar point types and tool assemblages in Wyoming. They also may provide comparative data and data for synthesis when studied with Plains Archaic sites along and near major drainages within the study area. In addition, in the area from Dinosaur National Monument to Douglas Pass and from the Utah border to Pinyon Ridge there are many recorded and unknown resources possibly dating from 10,000 years ago to the occupation of historic Utes. This complex area of sites is tentatively and analytically identified with the Desert Culture, Plains Archaic, Fremont culture and historic Utes.

Historic Resources

The history of this area has been described in the NWCCRES, where there is an inventory of historic sites in northwestern Colorado (also see Appendix A, Section 4). A narrative history of northwest Colorado can be found in An Isolated Empire: A History of Northwest Colorado by F.J. Athearn (1976).

During the first inventories in 1974-1975, 44 sites were recorded; 15 older sites were not included in the NWCCRES. These sites represent primarily later settlement (1915-1925) in the region and generally do not appear to qualify for the National Register of Historic Places according to the criteria set forth in 36 CFR 800.10. They are listed in Appendix A, Section 4.

Consultation with the State Historic Preservation Officer (SHPO) and the Federal Register indicates that the following historic sites are on the National Register of Historic Places (NRHP) or that they have been determined eligible for it: Private Car Marcia (Moffat County), Two Bar Ranch (Moffat County), Hahn's Peak Schoolhouse (Routt), and Battle of Milk River Site (Rio Blanco). The White-Indian Contact Site (Moffat County) and Old Ladore School (Moffat County) are also included.

Aesthetics

Visual Resources

The NWCCRES described the visual resoucres in the area covered by the report by discussing in general terms the landscape visibility (for clarification see NWCCRES and BLM Manual 6310), scenic quality (general), visual sensitivity levels, and existing man-made intrusions that affect(ed) the overall scenic quality of an area. Landscapes occurring in the report area are: Mountain shrubs, Pinyon-juniper, Creek bottoms, Sage - varying relief, River bottoms, Sage - minimum relief, Agriculture, Mountain shrub - varying relief, Hogbacks, Rugged mountain-high relief, Spoil pile remain, and Pinyon-juniper - varying relief.

The discussion of visual resources is broken down into the geographical areas below. Since the NWCCRES was completed, additional man-made intrusions have been introduced into some of these geographical areas. Where applicable, they are listed.

Eastern Routt County. Two high mountain valleys dominate this area: the Elk River Valley and the Upper Yampa Valley. Both are somewhat enclosed landscapes. Form and line dominate the angular pattern of fields which are dissected by fences, irrigation ditches, roads, and utility lines.

Landscape visibility in this area is generally high. Scenic quality in most of this area is outstanding, because of the landscape variety generated by the area's vegetation, topography, and rivers and streams. However, generally south of Yampa there is less landscape variety.

Most of this area is visible from the main highways and is therefore of high visual sensitivity. Most of the remaining area is visible from county roads and is therefore of moderate sensitivity.

A considerable amount of existing man-made visual contrast has been introduced by housing, ski area, and associated recreation facility development east of Steamboat Springs, near Hahns Peak, and east of Oak Creek. Colorado 131 enters a restricted landscape at Oak Creek Canyon where historic and present-day coal mining operations have adversely affected the landscape. Other adverse visual contrast are caused by existing surface mine operations at Energy Fuels and by roads, railroads, and electric transmission lines.

No significant additional man-made intrusions have been introduced since the NWCCRES was written.

Mt. Harris Area. Landscape visibility in this area is less than in eastern Routt County. Although areas adjacent to U.S. 40 have great exposure at short distances, landscapes further north and south are more distant and partially obscured from public access viewpoints by topography.

Scenic quality is characteristic to outstanding in the rolling to rugged mountain-high relief topography that dominates this portion of the county, extending from the Elkhead Mountains on the north to the Dunckley Flattops on the south. Scenic quality in adjacent landscapes is characteristic to minimal where topographic and vegetative variety is more subdued, or where intrusions are dominant.

Visual sensitivity for portions of this area is low because they are not visible from public roads, but most of this area is of moderate sensitivity, being visible from county roads. Those landscapes visible from U.S. 40 have high visual sensitivity.

Visual contrast of roads and industrial developments is low to moderate. Pipeline rights-of-way, oil and gas development (at Mt. Harris and Sage Creek), coal development (at the Seneca Mine), and the Hayden power plant are major visual intrusions.

Since the NWCCRES was written, additional visual contrasts have been introduced in this area by the Sun Coal Company. Its strip mining operation has introduced undesirable deviations in form, lines, colors, and texture from the existing landscape in the mining area. The coal loading facility along the Yampa River has introduced strong form, line, and color contrasts which are visible from U.S. Highway 40. The road and bench area adjacent to the river have introduced strong form and line contrasts. A conveyor belt system crosses the Yampa and provides for the loading of railroad coal cars. It has created strong line and color (blue) contrasts.

Western Routt County and Eastern Moffat County. Landscape visiblity in this area varies widely. The rolling landscapes are less visible than the mountains scattered throughout the area which are highly visible from all public access viewpoints. These include Cedar Mountain, Breeze Mountain, Juniper Mountain, Godiva Rim, and several peaks in the Slater Creek area. The landscapes adjacent to Craig are a combination of open range lands and agriculture, of characteristic to minimal scenic quality. However, scenic quality along the lower Yampa River, in Little Yampa Canyon, is outstanding, where landscape variety is much greater.

Other features in this rolling landscape of higher scenic qualtiy are Cedar Mountain, lying immediately northwest of Craig, and Godiva Rim-Bald Mountain, lying northwest of Maybell.

The Slater Creek area is isolated geographic entity that occupies the extreme northwest corner of Routt County; the landscape consists of sage with varying relief and several sharply angular prominnent peaks. Bounded by the Little Snake River and National Forest lands, portions of this area also exhibit outstanding scenic quality.

Those landscapes having high visiblility from major roads also have correspondingly high visual sensitivity. However, most of this area is of moderate sensitivity as several county roads are less traveled and therefore provide limited visual access.

Intrusions creating adverse visual contrast are powerline and pipeline rights-of-way and coal development. South of Craig are two large steel lattice tower powerlines which contrast with the rolling landscapes. Power plant construction has created additional line and form-dominant features that are also out of character with the surrounding landscape. An additional intrusion in eastern Moffat County is Empire Energy's railroad, which parallels the Yampa River south of Craig. Strong adverse effects in form, line, and color have been introduced where the railroad bed has been cut into the steep, south bank of the Yampa. Undesirable strong line deviation has been created by the rail bed and tracks across the agricultural lands from the intersection of Highway 13-789 and the Yampa River to the Empire Energy Mine.

Williams Fork Mountains. This landscape is highly visible from U.S. 40, Colorado 13, and the Williams Fork road. Further south near the Flattops however, the area has only moderate to low visiblity.

South of Craig lies an elevated mountainside of characteristic scenic quality. In the Williams Fork drainage rimrock outcrops and a pastoral-riparian riverbottom landscape dominates this outstanding scenery.

Visual sensivity for the most part is high; areas not readily visible, and landscape units that are encroached upon by visual intrusions have only moderate sensivity. Adverse effects on the landscape in this area derive largely from roads and utility lines. South of Craig and visible from town lie several coal exploration trails, roads, and fences that are strongly line-dominant features that contrast sharply with the natural landscape. No significant changes have occurred since the NWCCRES was written.

Axial Basin. Visibility of the Basin's rolling interior is moderate; however, all peripheral lands have a high visual exposure. The Basin itself exhibits gently undulating landscapes of sagegrass types and agriculture and exhibits minimal to characteristic scenic quality. Landscape variety on the Basin's periphery contributes characteristic to outstanding scenic quality.

Visual sensitivity for most of the Basin is moderate. Most of the eastern portion has a high visual sensitivity, being visible from Colorado 13. In this area roads and electric transmission lines adversely affect visual quality. On the south edge of Axial Basin and in the area of Streeter Canyon, the Colowyo Mine has introduced through its mining operations forms, lines, colors, and textures that create undesirable contrasts with the natural landscape. The dumping of spoils in Streeter Canyon has resulted in undesirable deviations in form, line, color, and texture that are visible from Highway 13/789.

Meeker Area. Landscape visibility is moderate to high for most of the area. The summit of Danforth Hills has low to moderate visibility, as it is not readily seen from public roads.

Yellowjacket Pass, Ninemile Gap, and the Wilson Creek Oil Field are placenames marking the Danforth Hills divide that separates the Yampa and White River drainages. Although the southern slopes of the mountains of the Danforth Hills are characterized by a rugged landscape of rimrock escarpments

and great variety, vegetative composition is rather uniform, so scenic quality varies from characteristic to outstanding. At the base of the escarpments are sagebrush and agricultural landscapes, of minimal to characteristic scenic quality. East of Meeker are the White River's pastoral and agricultural landscapes. Near the National Forest boundary greater topographic definition and vegetative variety result in outstanding scenery. West of Meeker a similar agricultural landscape of characteristic to outstanding scenery occupies Strawberry Creek drainage.

Visual sensitivity adjacent to Colorado 13 is high, but most of the rest of the area has low sensitivity.

East, and to a lesser extent west, of Meeker roads, trails, powerline and pipeline rights-of-way, adversely affect visual quality. Their contrast with the adjacent landscape is moderate to strong. No significant changes have occurred since the NWCCRES was written.

Rangely Area. Most of this area is only moderately visible.

Containing the town of Rangely and the Rangely Oil Field, the Rangely Anticline is the focal point of this area. Vegetative variety within this geologic structure is very sparse, and there are adverse visual effects created by the oil field. Scenic quality ranges from minimal to outstanding. Beyond the anticline, landscapes of characteristic scenery extend outward for several miles. A significant exception is the visual variety exhibited in the outstanding cliffs that flank the lower White River. The river upstream exhibits a river bottom landscape and fields. Characteristic to outstanding scenery is also inherent in both Coal Oil Rim and Pinyon Ridge.

Visual sensitivity for most of the area is moderate, but for the Colorado 64 corridor is high.

The area's dominant feature is the oil field itself with an array of roads, pipelines, and transmission lines; these contrast sharply with the characteristic landscapes. Pipeline rights-of-way, roads, and transmission lines adversely affect scenic qualtiy outside the oil field, though they are generally not dominant. No significant changes have occurred since the NWCCRES was written.

Blue Mountain - Skull Creek. Landscape visibility in this area is high, except for the upper Wolf Creek Area. The Skull Creek and Blue Mountain areas exhibit outstanding panoramic views.

Highway 40 marks the southern boundary of the outstanding scenery that extends toward Dinosaur National Monument. A series of hogbacks parallel Highway 40 and mark the southern boundary of a sharply-angular to gently-rolling landscape. Form, line, and color are all strongly displayed in the large-scale outcropping that surround Skull Creek Basin. A wide variety of patterns are created largely by pinyon-juniper, sagebrush, and other landscapes. The Wolf Creek drainage contains characteristic scenery that lies immediately north of Blue Mountain and Skull Creek.

Visual sensitivity for most of the southern portion of Blue Mountain, and Skull Creek is high. The remaining Wolf Creek Area is only moderately sensitive.

Seismic exploration trails, roads, and dozed fire breaks create low to moderate visual contrast with the natural landscape and adversely affect visual quality. No significant changes have occurred since the NWCCRES was written.

Western Moffat County North of Yampa River. Landscape visibility is highly variable. Most of the area is moderately visible but prominent peaks and hillsides are highly visible from the area's public roads. A landscape of largely sage and agricultural types extends throughout western Moffat County, differing from eastern Moffat County in that it exhibits more topographic and vegetative variety.

The landscapes of the Green River are dominant features of Browns Park with adjacent rugged mountain - high relief landscapes flanking the park on both sides. A pinyon-juniper landscape rises above sage types, resulting in characteristic to outstanding scenery. Cold Springs Mountain, Vermillion, and Lodore Canyons also exhibit characteristic to outstanding scenery.

Immediately south of Browns Park lies Dinosaur National Monument, containing characteristic to outstanding scenery. A rolling pine-clad landscape, Douglas Mountain, rises north of Yampa Canyon. East of the canyon lies the rounded massive form of Cross Mountain, which is sharply dissected on its southern flank by the Yampa River to form Cross Mountain Canyon. Below and north of the even-textured form of Cross Mountain stretches Sand Wash Basin. The basin consists of a dissected and gently sloping minimal to characteristic landscape that rises to the north; the sparsely vegetated area rises on three sides to form a broad open landscape. The basin's northern crest marks Vermillion Rim containing very highly dissected badlands.

Visual sensitivity for most of the area is moderate. Few areas have low sensitivity, as several roads intersect the area and provide visual access to almost all of the area. Seismic exploration trails are scattered throughout, adversely affecting scenic quality. No significant changes have occurred since the NWCCRES was written.

Recreation

Wild and Scenic Rivers

Three river segments within the study area are being studied for inclusion in the National Wild and Scenic Rivers System. The report is due October 2, 1979. The river segments are (1) the portion of the Elk River from its source to Clark, (2) the entire reach of the Green River that lies within the State of Colorado, and (3) the portion of the Yampa River within the boundaries of Dinosaur National Monument.

The Little Yampa Canyon section of the Yampa River appears to meet the criteria for a scenic river, based solely on observed resource values but has not been officially nominated or evaluated by the Heritage Conservation and Recreation Service, which is responsible for assessing wild and scenic river potential under P.L. 93-621, 1975.

Ecological Features

The study area contains one known pinyon-juniper relic area that lies about 10 miles west of Meeker; it is thought to contain trees about 500 years old.

Additional relic tree areas (areas where remnants of an ancient forest are found) have been identified in the region. Pinyon trees in the Skull Creek area have been analyzed at the University of Arizona's Laboratory of Tree Ring Research and determined to be 500 to 600 years old. A Ponderosa Pine relic area is located on Douglas Mountain but no tree ring dating has been done.

Primitive-Natural Values

The study area contains a portion of the 72,472-acre Mount Zirkel Wilderness Area, which straddles the Park Range north of Steamboat Springs, and the 235,000-acre Flattops Wilderness Area, which lies adjacent to the southeast corner of the study area. These areas lie wholly on National Forest lands. No designated primitive or wilderness areas now occur outside the National Forest boundary.

Section 603 of the Federal Land Policy and Management Act (FLPMA) requires that the Craig District of BLM inventory all public lands within the region for wilderness potential. All public lands administered by BLM, including ten wildland tracts in the western portion of the study area, shown in Table RII-24 and on Map Foldout 13 in Appendix B, NWCCRES, will be evaluated. Tracts having an area of 5,000 acres or more and both roadless and wilderness characteristics will become wilderness study areas. The Craig district plans to have all study areas identified by September, 1980. These study areas will then be further analyzed to determine their suitability for wilderness designation. Suitability reports are to be

submitted to the President and Congress. This wilderness review procedure must be completed by October 21, 1991.

Existing Recreation Developments

Existing recreation development is indicated on Map Foldout 12, Appendix B, NWCCRES.

U.S. Forest Service. The Routt and White River National Forests lie in the east and southeast parts of the study area, respectively. There are 25 National Forest campgrounds with a total of 373 camping units and seven picnic grounds with a total of 43 picnic units in the study area.

Dinosaur National Monument. Well-known for its assemblage of dinosaur fossils and spectacular canyons of the Green and Yampa Rivers, the monument contains 206,663 acres and straddles the Utah-Colorado state line. Scenic drives lead to overlooks, picnic areas, and campgrounds. There are 135 trailer campsites, 39 tent campsites, 60 picnicking sites, and five boat launching ramps, three of which are in Colorado. There are three regular campgrounds containing 45 units and nine primitive river camps in the study area portion of the monument. There are 23 camping units within three picnic grounds.

Visitation at Dinosaur National Monument from 1974 to 1977 has shown a yearly increase after dipping sharply in 1973 and 1974 due to the national energy crisis. Annual visitation and percent changes are as follows: 1975 - 380,836 visitors, +14.5 percent; 1976 - 401,549 visitors, +5.4 percent; and 1977 - 412,873 visitors, +2.8 percent.

Brown's Park National Wildlife Refuge. This wildlife refuge lies adjacent to the Green River and stretches from the Utah state line to Dinosaur National Monument and contains 4,416 acres. The refuge's primary purpose is waterfowl production, but there are open space camping, picnicking, and horseback riding also. About 10 and 15 camp sites are available at the swinging bridge and refuge headquarters, respectively. River floating, fishing, and birdwatching are other activities the area offers.

Colorado Division of Parks and Outdoor Recreation (DOP). The Colorado DOP maintains Steamboat Lake State Park north of Clark, which includes both Steamboat and Pearl Lakes. The Steamboat Lake area contains 2,679 acres and offers boating, water-skiing, and fishing. Three boat-launching ramps, 150 tent campsites, and 70 picnicking sites have been constructed. Pearl Lake has one launching ramp and 50 tent campsites; boating and fishing are its primary attractions.

Colorado Division of Wildlife (Colo. DOW). The Colo. DOW maintains a variety of recreational facilities in the study area: Service Creek, Indian Run, and Bel Air campgrounds and Cristina picnic ground. In cooperation with BLM, six primitive hunter camps are maintained on Cold Springs Mountain. There are four water-based recreation areas - Ralph

White Reservoir, Lake Avery, Elkhead Reservoir, and Rio Blanco Recreation Area. The Colo. DOW also maintains four fishing leases on the White River near Meeker and one on the Elk River north of Steamboat Springs.

Colorado Division of Highways (DOH). The Colo. DOH maintains one roadside rest-stop in the study area, west of Hayden on U.S. 40, containing four acres with 16 picnic sites.

Municipal-County. There are city parks in Steamboat Springs, Craig, Maybell, Rangely, and Meeker. Semi-public nine-hole golf courses are maintained at Steamboat Springs, Craig, Meeker, and Rangley. There are a variety of apparatus and game fields throughout the region, associated with various schools. Both Routt and Rio Blanco Counties have county-owned recreation sites. There are 30 municipal or county recreation areas in the study area.

Private Recreation. There are 121 private recreation areas in the study area: 34 in Moffat County, 40 in Routt County, and 47 in that portion of Rio Blanco County included in the study area. Most are hunting and fishing areas, campgrounds, picnic grounds, dude ranches, or recreation resorts. There are three ski areas, two of which were out of operation for the 1974-75 and 1975-76 ski season.

Both the American Sportsman's Club (ASC) and the International Sportsman's Club (ISC) have leases in the study area. Between the two clubs there are nine private lease areas for exclusive use of their members. Hunting and fishing are the chief activities.

Hunting.

Small Game - Waterfowl Hunting. By county, the most popular species based on number of hunters in 1975 was blue grouse in Routt County and cottontail rabbit in Moffat and Rio Blanco Counties (Table 2-24). The total number of activity days (participation in an activity for any part of a day) for the three counties was, in decreasing order, cottontail rabbit, dove, and blue grouse.

Big Game Hunting. Data on big game hunting for 1976 is summarized in Table 2-25. Big game management units and antelope management units are shown in Figures RII-25 and RII-26, Chapter II, NWCCRES. The game management units (GMU) in the region having the greatest number of hunter days by type of season are as follows: deer (regular season), GMU 3 -8,241 hunter days; deer (archery), GMU 23 - 979 hunter days; elk (regular season), GMU 12 - 15,777 hunter days; elk (archery), GMU 23 - 1,621 hunter days; bear, GMU 23 - 1,115 hunter days; and antelope, GMU A3 - 935 hunter days. GMU 3 and GMU A3 are located northwest of Craig and north of Maybell in Moffat County, Colorado. GMU 23 is generally east of Meeker in Rio Blanco County, Colorado. GMU 12 is east from State Highway 13/789, which runs north-south between Craig and Meeker, and includes an area in Moffat, Routt, and Rio Blanco Counties.

TABLE 2-24

1975 SMALL GAME-WATERFOWL PRESSURE

Animals	Routt				Moffat				Rio Blanco				Species Total	
	No. hunters	% of total 1/	No. days	% of total 1/	No. hunters	% of total 1/	No. days	% of total 1/	No. hunters	% of total 1/	No. days	% of total	No. hunters	No. days
Duck	83	0.24	-	-	267	0.77	-	-	110	0.32	-	-	460	-
Goose	36	0.17	-	-	159	0.73	-	-	-	-	-	-	195	-
Dove	215	0.52	573	0.29	667	1.64	5,284	2.65	169	0.42	276	0.14	1,051	6,133
Sage Grouse	497	11.85	1,138	13.61	1,015	24.21	1,994	23.85	111	2.65	270	3.23	1,623	3,402
Sharptail Grouse	345	75.49	771	79.32	112	24.51	201	20.68	-	-	-	-	457	972
Blue Grouse	1,782	14.86	4,699	14.33	174	1.45	566	1.73	332	2.77	701	1.01	2,288	5,966
Cottontail Rabbit	138	0.38	756	0.34	1,682	4.64	7,790	3.49	889	2.45	7,595	3.40	2,709	16,141
Snowshoe Hare	282	4.85	769	2.79	39	0.67	39	0.14	53	0.91	98	0.36	374	906
Coyote	163	1.25	516	0.41	96	0.70	672	0.54	170	1.23	714	0.57	429	1,902

1/ Percent of total for State of Colorado

Source: Colorado Division of Wildlife, 1975 Small Game, Furbearer, Varmint Report

TABLE 2-25

BIG GAME HUNTING PRESSURE - 1976

Parameters	Game management unit 1	2	3	4	5	10	11	12	13	14	15	23	24	26	441
Deer, Regular Season															
No. hunters	75	658	2,695	1,314	523	530	2,321	676	523	852	2,955	1,479	95	644	407
Resident	15	369	1,750	912	429	242	1,047	415	362	724	2,744	762	75	483	354
Non-resident	60	289	945	402	94	288	1,274	261	161	128	211	717	20	161	53
Hunters/sq-mi	0.64	0.57	2.00	2.67	1.69	0.64	2.71	1.32	1.46	1.54	6.11	3.34	2.53	2.86	1.81
Hunter days	275	2,206	8,241	4,441	1,496	1,690	7,525	2,080	1,848	2,690	3,283	4,681	423	748	1,231
Deer, Archery															
No. hunters	-	16	3	48	47	36	28	62	33	131	94	110	64	29	35
Resident	-	8	3	37	47	21	13	46	29	124	82	79	56	29	35
Non-resident	-	8	-	11	-	15	15	16	4	7	12	31	8	-	-
Hunters/sq-mi	-	0.01	0.002	0.10	0.15	0.04	0.03	0.12	0.09	0.24	0.19	0.25	0.14	0.13	0.16
Hunter days	-	76	45	321	167	209	195	470	240	800	668	979	550	104	283
Antelope															
No. hunters	74	327	787	10	343										
Resident	74	326	785	10	343										
Non-resident	-	1	2	-	-										
Hunter days	103	456	935	15	403										
Elk, Regular Season															
No. hunters	-	270	-	2,324	1,758	-	751	3,644	1,436	2,986	2,455	3,313	1,502	1,326	873
Resident	-	159	-	1,717	1,350	-	410	2,605	1,054	2,346	2,176	2,147	1,132	1,073	596
Non-resident	-	111	-	607	408	-	341	1,039	382	640	279	1,166	307	253	277
Hunters/sq-mi	-	0.23	-	4.72	5.67	-	0.88	7.13	4.00	5.38	5.07	7.48	3.21	5.90	3.88
Hunter days	-	1,251	-	9,951	7,851	-	3,307	15,777	6,749	14,156	11,155	13,248	7,417	6,119	9,951

Source: Colorado Division of Wildlife, 1976 Big Game Harvest Report

TABLE 2-25 (cont.)

BIG GAME HUNTING PRESSURE - 1976

Parameters	Game management unit														
	1	2	3	4	5	10	11	12	13	14	15	23	24	26	441
Elk, Archery															
No. hunters	-	-	-	18	7	-	33	85	37	7	28	169	154	35	20
Resident	-	-	-	11	7	-	14	46	18	7	21	78	103	22	14
Non-resident	-	-	-	7	-	-	19	39	19	-	7	91	51	13	6
Hunters/sq-mi	-	-	-	0.04	0.02	-	0.04	0.17	0.10	0.01	0.06	0.38	0.33	0.16	0.89
Hunter days	-	-	-	121	107	-	265	931	250	139	317	1,621	1,459	261	125
Bear															
No. hunters	4	6	6	76	31	-	6	56	13	90	47	158	62	30	22
Resident	-	2	4	58	28	-	4	38	9	69	39	105	46	28	20
Non-resident	4	4	2	18	3	-	2	18	4	12	8	53	16	2	2
Hunter days	35	19	32	576	247	-	45	389	79	754	352	1,115	458	224	149

Source: Colorado Division of Wildlife, 1976 Big Game Harvest Report

Demography

County and City Populations. Table 2-26 describes population trends in the three-county region between 1940 and 1977. Both Moffat and Rio Blanco (where the term Rio Blanco County is used in this study, it refers to the entire county, not just that portion included in the study area) Counties' populations increased steadily between 1940 and 1960. In contrast, the population of Routt County declined by nearly 44 percent. The main reason for this drop was the decline in the Routt County coal mining industry.

Between 1960 and 1970 the trends reversed themselves, with Moffat and Rio Blanco Counties declining slightly. This downward trend can be considered part of the general nationwide trend of migration from rural to urban areas as well as the lack of any offsetting growth of employment in the mining and recreation industries. Routt County, on the other hand, grew slightly as a result of development of the Steamboat Springs ski area.

Between 1970 and 1975, all three counties showed population growth: Moffat due to coal-related development, Rio Blanco because of new oil discoveries, and Routt due both to renewed coal mining activity and continued expansion of Steamboat Springs. With the exception of Rio Blanco, these trends have continued from 1975 to the present. Rio Blanco's population declined as the earlier oil boom passed its peak.

The local population centers include the municipalities of Craig, Dinosaur, Meeker, Rangely, Hayden, Oak Creek, Steamboat Springs and Yampa. Craig has traditionally been the largest community in the region, due to its historical role as a local agricultural and retail center and, more recently, due to the opening of several nearby coal mines and Colorado-Ute Electric Association's development of a 760-megawatt coal-fired generating plant 6 miles south of the town.

Meeker, like Craig, serves as an agricultural and retail center for the surrounding region, which is reflected in its slow but steady population growth between 1940 and 1977. Rangely, on the other hand, has grown more rapidly since the late 1950s, due to development of the nearby Rangely oil and gas field.

Steamboat Springs has a long-term population base founded on agriculture, mining, and retail trade. Its most rapid population growth has occurred since 1970 due to the development of a strong year-round recreation industry centered around the Mt. Werner ski area. Hayden has grown in population relatively rapidly since 1975, due principally to an influx of construction workers from Colorado-Ute's Craig and Hayden power plant projects. Oak Creek and Yampa have both experienced long-term population declines, but Oak Creek's proximity to Steamboat Springs has led to a near doubling of its population since 1970. Dinosaur's population has varied between 247 and 347 since 1960, the first year for which population data are available.

TABLE 2-26

COUNTY AND CITY POPULATION (1940-1977)

County City 1/	1940 Population	1950 Population	Annual Growth Rate 1940-1950 2/	1960 Population	Annual Growth Rate 1950-1960 2/	1970 Population	Annual Growth Rate 1960-1970 2/	1975 Population 3/	1977 Population	Annual Growth Rate 1970-1977 2/
Moffat	5,086	5,946	1.6	7,061	1.7	6,525	-0.8	8,336	10,303	6.7
Craig	2,123	3,080	3.8	3,984	2.6	4,205	0.5	5,426	6,677	6.8
Dinosaur	-- 4/	-- 4/	-- 4/	310	-- 4/	247	-2.6	311	347	5.0
Rio Blanco	2,941	4,719	4.8	5,150	0.9	4,842	-0.6	5,349	5,100	0.7
Meeker	1,399	1,658	1.7	1,655	0.0	1,597	-0.4	1,985	1,843	2.1
Rangely	-- 4/	808	-- 4/	1,464	6.1	1,591	0.8	1,792	1,871	3.3
Routt	10,525	8,940	-1.6	5,900	-4.2	6,592	1.1	9,858	10,516	6.9
Hayden	640	767	1.8	764	0.0	763	0.0	1,338	1,362	8.6
Oak Creek	1,769	1,485	-1.7	666	-8.4	492	-3.1	780	756	5.5
Steamboat Springs	1,613	1,913	1.7	1,843	0.4	2,340	2.4	3,013	4,028	8.1
Yampa	426	421	0.0	312	-3.0	286	-0.9	370	307	1.0
Region	18,552	19,605	0.6	18,111	-0.7	17,959	-0.1	23,543	25,919	5.6
Colorado	1,123,296	1,325,069	1.7	1,753,947	2.8	2,207,259	2.3	2,541,311	NA 6/	3.9 5/
Nation	132,164,569	151,325,798	1.4	179,323,175	1.7	203,211,926	1.3	213,540,000	NA 6/	1.0 5/

1/ All cities incorporated at the time of the 1970 Census are shown.
2/ Annual compound rate of change.
3/ Estimates as of July 1, 1975.
4/ Unincorporated at time of Census.
5/ Annual growth rate 1970-1975.
6/ NA = Not available

Sources:

1940, 1950, 1960, 1970, Department of Commerce, Bureau of Census, Census of Population.

1975, Department of Commerce, Bureau of Census, Current Population Reports: Population Estimates and Projections, Series P-25, No 694 (May 1977)

1977, Department of Commerce, Bureau of Census, Special Census - Official Population Count for Delta, Garfield, Mesa, Moffat, Rio Blanco and Routt Counties, Colorado, No 704, July 1977.

In addition, a number of communities outside the three-county study area face potential population impacts as a direct or indirect result of future developments, investigated in subsequent chapters of this study. The potentially affected communities include Rifle and Grand Junction, Colorado (1977 Special Census population, 2,244 and 27,799, respectively), and Vernal, Utah (1975 population estimated by the Census Bureau at 5,492).

Characteristics of the Populations. According to Table 2-27, growth in the region's population between 1970 and 1977 has been accompanied by growth in the number of persons residing in places classified according to the Census Bureau as "urban" (i.e., over 2,500 inhabitants). Nevertheless, by 1977 the region as a whole remained primarily rural. Between 1970 and 1977 there was a significant increase in the proportion of 20-24 and 25-34 year-olds in all three counties. This development reflects the influx of young mining, oil field, and construction workers (predominantly male occupations) as well as younger people of both sexes attracted by Steamboat Springs resort activity. Present data on the racial characteristics of the study area population for 1960 and 1970, the most recent year for which these data are available, indicate that the population remains overwhelmingly white in composition.

Table 2-28 presents vital statistics for the three-county region, including births, deaths, marriages, and divorce. Regional birth rates per 1,000 population were lower, and death rates higher, in northwest Colorado than for the state as a whole in 1970, reflecting the generally older composition of the local population. Regional birth rates increased significantly between 1970 and 1977, reflecting the increase in the number of persons in the prime child-bearing age brackets between 20 and 34 years old. Routt is the only county which experienced a decline in the birth rate, probably due to the large proportion of single people attracted to the Steamboat Springs ski area since 1970. The pronounced downward trend in regional death rates since 1970 reflects not only the younger age composition of the population but also the nationwide trend toward greater longevity.

The number of marriages in the region was slightly below the statewide figure in 1970, but increased markedly between 1970 and 1977 in the region as well as Moffat and Routt. The regionwide average number of divorces per thousand inhabitants was considerably below the statewide average in 1970, which is partly a reflection of the area's traditional, agrarian values. Between 1970 and 1977 the regional divorce rate increased by nearly 400 percent, from 1.5 to 7.4 per thousand population. This development is part of the nationwide trend toward increase in divorce but it probably also results from certain psychological and social stresses currently indigenous to the region. These stresses are engendered by the transient status of many new residents, conflicts between the values and attitudes of the established residents and those of the new population, and social and economic pressures affecting the whole community.

TABLE 2-27

POPULATION DISTRIBUTION

County	Total Population		Urban Population 1/		Rural Population 2/		Population per Square Mile	
	1970	1977	1970	1977	1970	1977	1970	1977
Moffat	6,525	10,303	4,205	6,677	2,320	3,626	1.4	2.2
Rio Blanco	4,842	5,100	0	0	4,842	5,100	2.8	2.9
Routt	6,592	10,516	0	4,028	6,592	6,488	1.5	2.4
Region	17,959	25,919	4,205	10,075	13,754	15,214	1.7	2.5

1/ Defined according to Census definition as persons residing in or near communities with over 2,500 inhabitants.

2/ Defined according to Census definition as other persons residing in areas other than communities with over 2,500 inhabitants.

TABLE 2-28

VITAL STATISTICS BY COUNTY

County	Births by place of residence				Deaths by place of residence				Marriages				Divorces and annulments			
	Number		Rate per 1,000 Population		Number		Rate per 1,000 Population		Number		Rate per 1,000 Population		Number		Rate per 1,000 Population	
	1970	1977	1970	1977	1970	1977	1970	1977	1970	1977	1970	1977	1970	1977	1970	1977
Moffat	98	212	15.0	20.5	56	70	8.6	6.8	73	126	11.2	12.2	9	79	1.4	7.7
Rio Blanco	82	121	16.9	23.7	48	33	9.9	6.5	49	45	10.1	8.8	7	28	1.4	5.5
Routt	130	182	19.7	17.3	65	60	9.9	5.7	67	143	10.2	13.6	12	86	1.8	8.2
Region	310	515	17.3	19.9	169	163	9.4	6.3	189	314	10.5	12.1	28	193	1.5	7.4
Colorado	41,570	43,056	18.8	NA 1/	17,433	17,875	7.9	NA	24,988	30,063	11.3	NA	10,400	20,557	4.7	NA

1/ NA = Not available.

Source: U.S. Department of Health, Education, and Welfare, Public Health Service, Health Resources Administration, National Center for Health Statistics, Vital Statistics of the United States. Volumes I, II, and III, 1970.

Colorado Department of Health, Office of Vital Statistics, 1977.

Employment. Table 2-29 presents estimates of wage and salary employment by industrial sector in 1977 for Moffat, Rio Blanco, and Routt Counties. According to Table 2-29, agriculture and manufacturing are relatively insignificant as sources of local employment.

Mining employment (i.e., coal, oil and gas, oil shale extraction) is fairly evenly distributed in absolute terms among the three counties, but varies considerably in relative terms, from 8.2 percent of total employment in Moffat County to 26.1 percent in Rio Blanco.

The great concentration of construction workers in Moffat County reflects the large construction workforce at the Craig Power Plant (Units 1 and 2), which employed an estimated 1,420 construction workers in 1977.

Trade, finance/real estate/insurance, and services are especially important in Routt County, where they collectively account for nearly half of total county employment. A large proportion of Routt County employment in trade and services sectors is tourism and recreation oriented, drawing its lifeblood from the Steamboat Springs recreation area. Steamboat also serves as the hub of the region's finance, real estate, and insurance industries.

There is a proportionally high amount of employment by state and local government, accounting for between 18.2 and 26.4 percent of total employment in each of the three counties. As indicated in Table 2-30, unemployment varies considerably among the counties. Rio Blanco County's extremely low unemployment rate has been the result of diminishing population and labor force rather than the expansion of employment opportunities.

TABLE 2-30

ANNUAL UNEMPLOYMENT RATES (PERCENT)

County	1973	1974	1975	1976	1977
Moffat	4.8	3.6	7.5	7.3	8.0
Rio Blanco	4.0	2.7	3.8	3.8	3.0
Routt	5.0	6.0	8.0	7.3	7.9
Colorado	4.1	4.0	6.9	5.9	5.6
United States	4.9	5.6	8.5	7.7	7.0

Source: Colorado Department of Labor and Employment, Division of Employment Research and Analysis, Average Monthly Labor Force for Calendar Years 1973, 1974, 1975, 1976, 1977; U.S. Department of Commerce, Bureau of Economic Analysis, Survey of Current Business.

TABLE 2-29

COUNTY EMPLOYMENT BY SECTOR
1977

Sector	Moffat		Rio Blanco		Routt	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
Agriculture	191	2.9	131	5.7	168	3.3
Manufacturing	148	2.2	62	2.7	152	3.0
Coal mining	533	8.2	11	0.5	469	9.3
Oil and gas extraction	0	0.0	605	26.1	0	0.0
Shale oil extraction	0	0.0	0 1/	0.0	0	0.0
Construction	1,956	30.1	204	8.8	536	10.7
Transportation, communications, utilities	379	5.8	220	9.5	282	5.6
Trade	872	13.4	229	9.9	951	19.0
Finance, insurance, real estate	161	2.4	74	3.2	383	7.6
Services	716	11.0	127	5.5	1,081	21.5
State and local government	1,459	22.4	612	26.4	912	18.2
Federal government	71	1.0	39	1.7	83	1.7
Total 2/	6,486	100.0	2,314	100.0	5,017	100.0

1/ Does not include 104 temporary construction workers on C-a Shale Oil Tract in 1977; the latter are included under construction sector.
2/ Totals may not add to 100.0 percent due to rounding.

Moffat and Routt Counties have both had relatively high unemployment rates (near or above the nationwide average) since 1975. In Moffat County, construction of the Craig Power Plant and expectation of future coal-related development has led to an influx of persons seeking employment in the services sector. This influx has exceeded the immediate capability of the local economy to absorb (Huber, personal communication, 1978). This may in part be attributable to high housing and living costs, which may have increasingly led to spouses seeking work in order to supplement the family's income. In Routt County, the high unemployment rate is attributable mainly to the large number of young people seeking work in the vicinity of the Steamboat Springs ski resort.

Income. According to Table 2-31, oil and gas was the most important source of 1977 wage and salary earning in Rio Blanco County. While coal mining earnings were similarly important in Moffat and Routt, they were eclipsed in 1977 by construction, which contributed 44.9 and 20.6 percent of total wage and salary earning, respectively. Such a great degree of dependence on construction earnings makes the area economically very vulnerable to fluctuations in the construction sector, such as that caused by completion of large projects like Units 1 and 2 of the Craig Power Plant in Moffat County. While trades, services, and local/state government account for much employment, they are not proportionally important as sources of income due to relatively low average-earnings levels.

The differences in the average worker's earnings among the counties is due to varying wage rates among employers. Table 2-32 details average annual wage and salary levels for different sectors in 1976. The highest-paying sectors for Colorado were mining, construction, and the federal government. Moffat and Rio Blanco Counties enjoyed relatively high average earnings levels in 1977 due to the relatively large number of highly paid mining and construction workers. Average earnings levels in Routt County were somewhat lower due to the greater concentration of workers in the lower-paying sectors, especially trades and services.

Investment Patterns. Estimates of major private investments by sector in 1977 indicate concentration in two sectors, coal mining (3.6 million) and power plant construction (141.5 million), with the latter predominating. The 141.5 million represents only a single year's installment on the $700 million cost of the Craig Power Plant (Units 1 and 2).

In terms of their impact on local governments' property tax base, generally only the county governments and the school districts in which they are situated experienced a direct impact from the above investments, since the latter are situated on unincorporated land outside the municipalities' taxing jurisdiction. Municipalities have to provide public facilities and services (e.g., water, sewer, police and fire protection) to the new population generated by investment in coal and other sectors, but their property tax base increases

TABLE 2-31

WAGE AND SALARY INCOME BY SECTOR
1977

	Moffat		Rio Blanco		Routt	
	Millions of dollars (1976)	Percent of total	Millions of dollars (1976)	Percent of total	Millions of dollars (1976)	Percent of total
Agriculture	1,030	1.4	706	3.0	906	2.1
Manufacture	1,623	2.2	680	2.9	1,666	3.8
Coal mining	8,257	11.3	0	0.0	7,436	17.0
Oil and gas extraction	0	0.0	8,037	33.8	0	0.0
Shale oil extraction	0	0.0	0 1/	0.0	0	0.0
Construction	32,845	44.9	3,426	14.4	9,001	20.6
Transportation, communication, utilities	4,733	6.5	2,747	11.6	3,521	8.1
Trade	6,741	9.2	1,770	7.5	2,180	5.0
Finance, insurance, real estate	1,260	1.7	579	2.4	2,998	6.9
Services	5,535	7.6	982	4.1	8,357	19.1
State and local government	10,029	13.7	4,207	17.7	6,269	14.4
Federal government	1,130	1.5	621	2.6	1,321	3.0
Total	73,183	100.0	23,755	100.0	43,655	100.0
Average earnings per worker (residence adjusted)	11,044		10,508		9,087	

1/ Does not include earnings of 104 temporary workers on C-a Shale Oil Tract, who are included under construction sector.

TABLE 2-32

ESTIMATED AVERAGE ANNUAL WAGE AND SALARY EARNINGS
IN COLORADO BY MAJOR SECTOR
1976

Sector	Average annual earnings
Agriculture	$ 5,392 1/
Mining	
Coal	15,492
Oil/gas extraction	13,284
Construction	16,792
Manufacturing	10,963
Transportation, communications, utilities	12,487
Wholesale trade	10,638
Retail trade/services	7,731
Finance, insurance, real estate	7,828
State and local government	6,874 1/
Federal government	15,921 1/

1/ Average earnings in agriculture, state/local and federal government estimates based on Bureau of Economic Analysis 1975 data inflated to 1976 using Western State Consumer Price Index. Data for other sectors from Colorado Job Services.

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Local Area Personal Income, 1970-1975 (Washington, D.C., 1977).

Colorado Division of Employment, Colorado Manpower Review, July, 1976.

only indirectly as a result of the investments, limited to additional assessments on employees' homes and associated commercial development.

Retail Trade. The close correlation between county retail sales and county earnings as a percentage of the respective regional totals (Table 2-33) indicates that the three counties are equally capable of meeting their residents' retail trade needs. Retail sales on the sub-county level present a hierarchical pattern of trade relations, with one municipality clearly the dominant trade center in each county.

According to Table 2-33, Craig is the dominant trade center in Moffat County, with 64.8 percent of the county's population in 1977 and 82.7 percent of its fiscal 1977 retail sales. This implies that Craig is meeting not only its own residents' retail demand but a large proportion of other residents' retail demand as well.

Although retail sales in Rio Blanco and Routt Counties are geographically more dispersed than in Moffat, the same pattern recurs, with Rangley and Steamboat Springs the dominant retail trade centers.

Retail trade is important to the local communities as a source of employment and, to a lesser extent, earnings (refer to the preceeding discussions of employment and income). In addition, it generates local public revenues through the sales tax mechanism (see discussion of local government finances below).

Local Services. The present level of public services--police, fire, water, sewer, and solid waste--as well as improvement are presented in Tables 2-34 and 2-35. Planned changes are not necessarily assured. They are often dependent on the availability of relatively scarce local funds or outside funds, primarily state and federal monies.

All municipalities provide police, fire, water, sewer, and solid waste disposal sites. Local police protection is augmented in most municipalities by members of the county's Sheriff's Office or the State Highway Patrol who live in those municipalities. A court system and jail are provided by each county and serve all its municipalities. All municipalities in northwest Colorado are rated by Insurance Services Office of Denver, Colorado, as having inadequate fire protection because of inadequate equipment, water service, or lack of an organized fire department. All water systems in the county are publicly owned. Water and sewer services are the highest priorities of most local officials and are those most often undergoing improvements. For the majority of communities there is no collection service for solid waste.

Housing. Housing data for Moffat, Rio Blanco, and Routt Counties are present in Table 2-36. Since 1970, the number of year-round housing units in the three counties has increased. Routt County has had the highest annual growth rate. Since 1970, the proportion of single family units in the Moffat County housing supply has decreased while the proportion of mobile homes has increased.

TABLE 2-33

RETAIL SALES BY COUNTY AND MUNICIPALITY
FISCAL 1976-1977

County/ municipality	Retail sales (thousands of dollars)	Percent of county retail sales	Percent of county population	County sales as percent of total regional sales	County earnings as percent of regional earnings
Moffat	79,401			46	49
Craig	65,667	82.7	64.8		
Dinosaur	755	1.0	0.9		
Rest of county	12,979	16.3	34.3		
Rio Blanco	31,000			17	18
Meeker	9,493	30.6	36.2		
Rangely	18,228	58.8	36.7		
Rest of county	3,279	10.6	27.1		
Routt	65,219			37	33
Hayden	3,567	5.5	13.0		
Oak Creek	1,707	2.6	7.2		
Steamboat Springs	43,778	67.1	38.3		
Yampa	703	1.1	2.9		
Rest of county	15,464	23.7	38.6		
Region	175,620,271	100	100	100	100

Source: Colorado Department of Revenue, Annual Report 1977, Denver, 1978.

TABLE 2-34

EXISTING LOCAL SERVICES

Services	Craig	Dinosaur	Meeker	Rangely	Hayden	Oak Creek	Steamboat Springs	Yampa
Police								
Service area	Metro area	None	City limits	City limits	Town	City limits	Metro area	-
Officers, full-time	17		4	4	3	1	14	0
Officers, part-time	0		0	0	0	0	0	1
Search and rescue volunteers	10		0	0	0	0	0	0
Clerical/support staff	8		0	0	0	0	9	0
Vehicles, marked patrol	6		2	4	2	1	6	1
Vehicles, other	0		0	0	0	0	-	0
Facilities	County jail		County jail	Jail for 8	None	Steamboat jail	-	None
Fire								
Service area	Metro area	City limits	City limits	City limits	Town + 10 miles	City limits	Metro area	-
Firefighters, paid	0	0	0	0	0	0	0	0
Firefigheres, volunteer	25	12	30	22	18	22	14	12
Vehicles, firefighting	8	1	3	4	5	2	3	1
Pumping capacity	2,800 gpm	750 gpm	1,225 gpm	1,000 gpm	2,500 gpm	1,250 gpm	1,250 gpm	250 gpm
Vehicles, ambulance/rescue	2	0	2	1	1	1	2	1
Fire protection rating	8	9	7	8	9	9	8	9
Water								
Service area	Metro area	City limits	Town area	City limits	Town	City limits	Metro area	Town
Supply capacity	5 MGD	.274 MGD		216 MGD	.5 MGD	1.4 MGD	5 MGD	1.2 MGD
Peak demand	4 MGD	.158 MGD	1.3 MGD	1 MGD	.585-1.7 MGD	.2 MGD	2.7 MGD	0.288 MGD
Source	Yampa River	4 wells	Well field	White River	Yampa River	Trout and Oak Creek	Fish Creek Reservoir	Spring
Treatment	Sand filter	None	Chlorination	Chlorination	Sand filter	Rapid sand filter	Chlorination	Chlorination
Customers	8,000 - 10,000	350 - 400	2,000	2,300	1,500	756	11,000	310
Sewer								
Service area	Metro area	City limits	City limits	City limits	Town	City limits	Metro area	Town
Treatment capacity	2.5 MGD	.17 MGD	.4 MGD	1.7 MGD	.75 MGD	.35 MGD	2.5 MGD	0.084 MGD
Peak demand	-	-	-	-	.60 MGD	-	1.2 MGD	.05-.07 MGD
Treatment type	Aerated lagoon	Primary lagoon	Extended aeration	Aerated lagoon	Primary lagoon	Extended aeration	Aerated lagoon	Aerated lagoon
Customers	8,000 - 10,000	350 - 400	2,000	2,300	1,500	756	11,000	310

TABLE 2-35

PLANNED CHANGES IN LOCAL SERVICES

Town	Police	Fire	Water	Sewer
Craig	Moving to new facilities which include 1 holding cell.	None	Treatment plant to be expanded by 1980. No capacity figures currently available.	Federal grant received to increase capacity to 3.4 MGD by 1980.
Dinosaur	None	None	Planning for an additional 5,000 gallon storage tank in the near future.	None
Meeker	Within 2 years plan to add: 1 patrol officer, 1 sergeant, and 1 dog catcher.	None	In 12-18 months, double capacity by adding two wells.	Expansion of treatment facility in 1979. EPA funding. No capacity figures currently avai able.
Rangley	None	Planning to expand to a force of 30, acquisition of new off-road vehicle.	Additional distribution lines.	None
Hayden	None	New truck ordered with a pumping capacity of 750 gpm.	1.3 MGD treatment plant under construction. 1 million gallon storage tank under construction.	Currently number one o state priority list fo secondary treatment, t be operative by 1980-1981.
Oak Creek	Hiring 1 additional officer in 1979.	None	Plan to upgrade plant, replace feeder lines, expand reservoir.	None
Steamboat Springs	4 additional officers.	1 additional truck.	None	New sewer lines and a secondary waste treatment plant will be online in 1979.
Yampa	None	Seeking funds for a firetruck with 250 gpm pumping capacity.	Additional distribution lines, 125,000 gallon storage facility, upgrading of water distribution lines.	None

TABLE 2-36

HOUSING SUPPLY AND AVERAGE ANNUAL GROWTH RATES
1970 - 1977

County	1970 Units		1977 Units		Average annual growth rate, 1970 - 1977 (%)
	Number	Percent of total 2/	Number 1/	Percent of total 2/	
Moffat					
Single family	1,890	76.8	2,069	54.8	1.3
Multiple family	371	15.1	584	15.5	6.7
Mobile home & other	199	8.1	1,125	29.8	28.1
Total units	2,460	100.0	3,778	100.0	6.3
Rio Blanco					
Single family	1,450	77.1	1,621	74.2	1.6
Multiple family	215	11.4	225	10.3	0.7
Mobile home & other	216	11.5	340	15.6	6.7
Total units	1,881	100.0	2,186	100.0	2.2
Routt					
Single family	2,291	79.0	2,851	50.0	3.2
Multiple family	374	12.9	2,132	37.4	28.2
Mobile home & other	234	8.1	715	12.5	17.3
Total units	2,899	100.0	5,698	100.0	10.1

1/ Estimated.
2/ Percentages may not total 100.00 due to rounding.

Source: U.S. Department of Commerce, Bureau of Census. 1970 Census of Housing. Vol. 1, Part 7, 1972.
Estimates based on State of Colorado. Department of Local Affairs, Division of Housing, Housing in Colorado: Estimates of Housing Inventory and Household Characteristics for January 1, 1977 and Projections of Household Growth to January 1, 1982, March, 1978.

Mobile homes were almost 30 percent of the total housing stock in 1977. The dramatic increase in mobile homes during this period can be attributed to the influx of workers at the Craig Power Plant, coal mining, and other industries that moved into the area at the same time.

The proportion of single family units in Rio Blanco County has also decreased since 1970, while the proportion of mobile homes has increased. New oil discoveries in Rio Blanco County since 1970 have attracted some additional population, increasing the need for immediately available housing units. In Routt County, the most dramatic change has been in the proportion of multiple family units. Many of the multi-family units were built as part of the ski and recreation development at Steamboat Springs. Some of these units are second homes and are not used year-round.

The estimated number of housing starts between 1970 and 1976 are shown in Table 2-37. More than half of the units started in Moffat and Routt Counties were multiple dwellings, compared to 13 percent in Rio Blanco County. In Moffat County, the multi-family units were needed for workers moving into the area on a temporary basis who preferred not to or were unable to invest in a single family house or mobile home. In Routt County, many of the multiple dwellings were built as part of the ski and recreation development near Steamboat Springs.

Available housing for rent or sale in northwest Colorado is scarce in spite of recent increases in the housing stock. Housing in the region is expensive as well as scarce. Depending upon the number of bedrooms, lot size, and amenities, new housing in Craig is selling for between $50,000 and $60,000 (Conley, personal communication, 1978); in Meeker, between $40,000 and $60,000 (Cox, personnal communication, 1978); and in Steamboat Springs, between $65,000 and $80,000. A popular size mobile home, 14 by 70 feet, sells for between $14,500 and $25,000 (Taylor, personal communication, 1978). Rental units in Craig, Meeker, and Hayden are about $300, not including utilities.

Education. Seven school districts serve northwest Colorado. The school facilities in the districts are listed in Table 2-38. New school facilities are currently being built or are planned in the Craig, Meeker, Hayden, and South Routt School District. An addition to an existing school is being constructed in the South Routt district and a new elementary school is scheduled to open in the fall of 1978 in the Rangley School District.

Table 2-39 displays comparative school district enrollment data for 1976-77 and 1977-78. The Moffat County School District RE#1, the most populous in the region, is currently operating at capacity, with modular classrooms to supplement the permanent spaces. The crowded conditions experienced by the Hayden School District in 1977-78 will be relieved in January, 1979, when the new Hayden Elementary School, with a capacity of 500, will open. Steamboat Springs elementary schools are crowded. Two modular classrooms will be used beginning in fall, 1978. Routt School District RE#3, serving Oak Creek and Yampa, is the least populous district in the three-county area. Due to problems of distribution, the elementary school is crowded.

TABLE 2-37

ESTIMATED NUMBER OF HOUSING STARTS
1970 - 1976

County	Single family		Duplex		Multiple dwelling		Total
	Number	Percent of total	Number	Percent of total	Number	Percent of total	
Moffat	313	46	16	2	346	51	675
Rio Blanco	201	83	8	3	32	12	241
Routt	610	25	138	6	1,670	69	2,418

Note: Percentages may not add due to rounding.

Source: State of Colorado, Division of Housing, Department of Local Affairs, Housing on Colorado: Estimates of Housing Inventory and Household Characteristics for January 1, 1977 and Projections of Household Growth to January 1, 1982.

TABLE 2-38

SCHOOL DISTRICT FACILITIES

County School district	Number and type of schools	Planned changes
Moffat		
Craig - RE#1	3 Elementary 1 Junior high 1 High school 3 Outlying rural	Construction of a new high school to be ready by about 1981. Renovations of the existing high school. Adjustments to grade alignments of schools when new high school completed.
Rio Blanco		
Meeker - RE#1	1 Elementary 2 Secondary 1 Outlying rural	Improvement to core high school facilities. Use of junior high for elementary school classes. Construction of a new elementary school.
Rangely - RE#4	1 Elementary 2 Secondary	Use of a satellite cottage kindergarten. New elementary school to open in fall 1978.
Routt		
Hayden - RE#1	1 Elementary 1 Junior-senior high	New elementary school to open in January 1979. Existing elementary school to be used for junior and high school needs after new elementary school opens.
Steamboat Springs - RE #2	1 Elementary 1 Junior high 1 Senior high	Two modular classrooms to be used for elementary classes beginning fall 1978.
South Routt - RE #3	1 Elementary 1 Junior high 1 Senior high	New addition to existing elementary school to be ready for fall 1978. Construction for a new high school. Upon completion of the new high school, existing high school to be used as the junior high and existing junior high to be used for elementary school classes.

Source: State of Colorado, Department of Education, Consolidated Report on Elementary & Secondary Education in Colorado, 1978, Denver, Colorado, February, 1978.

Telephone conversations with school superintendents of respective districts, or with their representatives, July 10 and 11, 1978.

TABLE 2-39

FALL MEMBERSHIP, CURRENT CAPACITY, FULL-TIME EQUIVALENT TEACHERS, STUDENT/TEACHER RATIOS, AND PROJECTED CAPACITY

County School district	Fall membership 1976-1977	 1977-1978	Current capacity	Full-time equivalent teachers	Student/ teacher ratios	Projected capacity
Moffat						
Craig - RE #1	2,357	2,464	2,430	125.1	19.6	3,780
Rio Blanco						
Meeker - RE #1	727	728	1,090	39.4	18.4	1,430
Rangely - RE #4	617	617	1,070	43.0	14.3	1,270
Routt						
Hayden - RE #1	518	508	622	36.0	14.1	1,622
Steamboat Springs - RE #2	1,296	1,418	1,681	77.5	18.2	1,736
South Routt - RE #3	445	483	503	30.5	16.1	830
Three-county area	5,960	6,218	7,373	351.5	17.7	10,743
State	567,087	561,807	N.A.	28,664	19.6	N.A.

Source: Colorado Department of Education, Consolidated Report on Elementary and Secondary Education in Colorado, 1978, Denver, Colorado, 1978.

Pupil Membership and Related Information, Fall 1977, Denver, Colorado, February, 1978.

Projected capacities for the various school districts were provided by superintendents or their representatives in each district. Routt RE #2 figures were obtained from A Study of the Routt School District, RE #2 Facility Needs, Bureau of Educational Research, University of Denver, Denver, Colorado, 1974.

Three mobile classrooms (combined capacity, 75) were filled to capacity during 1977-78. A new elementary school will be ready for fall, 1978.

The Meeker School District, although among the smallest in terms of enrollment and assessed valuation, had among the highest expenditure/assessed valuation per pupil in 1978 in the three-county region. The large assessed valuation in the Rangley District is due to construction of a new elementary school, scheduled to open in September, 1978.

Health and Social Services. Four hospitals, located in Craig, Meeker, Rangely, and Steamboat Springs, serve northwest Colorado. Data on these facilities are shown in Table 2-40. Memorial Hospital in Craig is currently building a new addition and adding 12 beds, which will increase its total number of beds to 42. With the completion of the expansion of Memorial Hospital, there will be a total of 107 hospital beds in the three-county region. This is more than adequate to meet the needs of the current population. The regional occupancy rate of the four hospitals, 45.3 percent (which does not include the new beds at Memorial Hospital), is below the occupancy goal of 62.5 percent for hospitals with 25 beds (Western Colorado Health Systems Agency 1978a). The average number of hospital beds in the region, not including the bed expansion at Memorial Hospital, is 24.

There are four nursing homes in northwest Colorado providing skilled, intermediate, and residential care. Data on these facilities are also shown in Table 2-40.

There are no inpatient psychiatric or rehabilitative facilities in northern Colorado. These types of facilites are available in Grand Junction and Denver. Mental health centers are located in Craig, Meeker, Rangley, Steamboat Springs, Hayden, and Oak Creek.

Table 2-41 presents data on health care personnel serving northwest Colorado. The number of physicians working in Rio Blanco and Routt Counties in 1976 was more than adequate to serve the population, but in Moffat County there was a slight shortage of physicians. There was an adequate number of registered nurses in the three-county region.

The largest number of cases among income maintenance programs supervised by the Department of Social Services was in the category of Aid to Families with Dependent Children (AFDC). Moffat and Routt Counties received about an equal proportion of the dollars spent on AFDC cases in the region, which was higher than that received in Rio Blanco County. There were no Aid to the Blind cases reported in any of the three counties.

TABLE 2-40

HEALTH FACILITIES
1976

County City	1976 Population	Hospitals Number	Hospitals Beds	Hospitals Occupancy rate (%)	Nursing home facilities Number	Nursing home facilities Beds	Nursing home facilities Occupancy rate(%)
Moffat	8,900						
Craig 1/		1	30	66.7	2	24	74.9
						58	93.4
Rio Blanco	5,300						
Meeker		1	17	29.4	1 2/	25	96.6
Rangely		1	28	25.0	0		
Routt	10,200						
Steamboat Springs		1	20	55.0	1	60	76.7
Region		4	95	45.3	4	167	N.A. 3/

1/ The hospital in Craig is currently being expanded to 42 beds.
2/ Long-term care unit of a hospital.
3/ N.A. - Not available.

Source: American Hospital Association, AHA Guide to the Health Care Field, 1977 ed.

Western Colorado Health Systems Agency, Task Force on Institutional Long Term Care Services. Impatient Long Term Care Services Plant for Western Colorado, 1978-1983. Grand Junction, Colorado, 1978.

TABLE 2-41

HEALTH CARE PERSONNEL
(population per health care specialist)

County	1976 Population	Physicians 1/	1972 Population	Registered Nurses
Moffat	8,900	2,225	6,400	246
Rio Blanco	5,300	1,325	4,700	180
Routt	10,200	1,275	8,100	238

1/ By place of work.

Source: U.S. Department of Commerce, Bureau of the Census. Population Estimates, 1972 and 1976.

Colorado Department of Health, Health Information Services, Survey, 1976.

Margolis, Eric. A Social-Economic Profile of the Tri-County Area of Northwest Colorado, prepared for the Craig District Office, Bureau of Land Management, September, 1976.

Local Government Finances. The amounts spent by local governments on various public functions (e.g., police, public works, health, sewage treatment) vary from community to community according to the needs and preferences of local residents as expressed by their elected representatives. Table 2-42 summarizes local government's operating and capital expenditures by major budgetary activity in fiscal 1977-1978. A community's capital expenditures generally vary widely from year to year whereas operating expenditures on individual budgetary items tend to remain constant over the short term, at least as a percentage of total operating expenditures.

Table 2-43 compares local governments' operating expenditures as a percentage of total operating expenditures. The table reveals significant divergences in local budgetary priorities in all categories except public safety (i.e., law enforcement and fire protection), to which most jurisidictions devote about 20 percent of their available resources.

Like expenditures, local governments' revenue structures vary widely. Fiscal 1977-78 revenues in each jurisdiction are summarized in Tables 2-44 and 2-45, which display total and per capita revenues, respectively. County governments in general are more dependent than municipalities on property tax revenues, obtaining up to 81 percent of total revenues from this source (Rio Blanco County).

Property taxes generally account for 20 to 30 percent of municipal revenues. Sales tax collections are generally the other most important source of municipal revenues, even exceeding property tax revenues in some jurisdictions (notably Craig and Steamboat Springs, where sales taxes generate 55 percent of total revenues).

Due to cost and other development, population growth has required that several local governments increase their base. These governments have adopted three general strategies in attempting to meet their revenue needs.

The first strategy is one of tax diversification. By spreading the tax burden, a tax levying unit can minimize the tax burden placed on property owners.

The next strategy involves incurring additional bonded indebtness. Table 2-46 illustrates the present bonded indebtedness and the legal debt limits of each governmental unit in the region. Additional bond issues must have the approval of the local voters, which may not always be forthcoming. Bond issues can only be used for capital projects.

The third strategy consists of seeking out additional sources of intergovernmental revenues, including grants and loans from agencies such as the Environmental Protection Agency, the Economic Development Administration, Housing and Urban Development, and Farmer's Housing Assistance funds.

In an effort to meet the growing demand for intergovernmental revenues in coal development areas, the Colorado legislature has recently adopted a

TABLE 2-42

TOTAL EXPENDITURES BY MAJOR ACTIVITY
FISCAL 1977-1978

County / City	General administration		Public safety		Health care		Public works		Recreation		Airport		Water and sewer		Miscellaneous		
	Capital	Non-capital	Capital	Non-capital	Capital	Non-capital	Capital	Non-capital	Capital	Non-capital	Capital	Non-capital	Capital	Non-capital	Capital	Non-capital	Total
Moffat		$607,741		$221,516		$ 67,800				$114,761		$ 3,600					$1,015,421
Craig	$670,875	335,000		341,000			$905,726	$448,000	$127,000	62,000			$ 980,125	$408,000		$424,000	4,701,725
Dinosaur		5,061		6,523		1,900		11,615								9,208	34,307
Rio Blanco		512,122		153,351		69,162		1/		31,891		39,306				31,445	837,277
Meeker	5,371	30,413	$5,225	67,132			54,381	78,828	2,100	58,908			1,200	163,629			467,160
Rangely		123,051	7,000	55,664		24,686	16,000	55,672		12,500			1,346,272	207,140			1,748,825
Routt		767,950		340,970		136,720				14,500		80,330			$39,380	5,510	1,385,360
Hayden		60,000		49,000		1/		36,000		3,150						24,000	172,150
Oak Creek		15,548	721	23,370		1/		38,885		588						6,795	85,583
Steamboat Springs		520,429		437,885				442,767		119,987				246,385			1,767,463

1/ Negligible amount (in which case it is included in totals) or zero.

Source: Local Budgets.

TABLE 2-43

PERCENTAGE OF OPERATING EXPENDITURES FOR MAJOR ACTIVITIES
FISCAL 1977-78

County City	General administration	Public safety	Health care	Public works	Recreation	Airport	Water/ sewer	Miscellaneous	Total
Moffat	60	22	7	1/	11	1/	1/	1/	100
Craig	17	17		22	3		20	21	100
Dinosaur	15	19	5	34	1/	1/	1/	27	100
Rio Blanco	61	18	8	1/	4	5	1/	4	100
Meeker	7	17	1/	20	15	1/	41	1/	100
Rangely	33	15	7	15	3		28		100
Routt	57	25	10	1/	1	6	1/	2	100
Hayden	35	28		21	2	1/		14	100
Oak Creek	19	27		45	2	1/		8	100
Steamboat Springs	29	25	1/	25	7	1/	14	1/	100

1/ The level of this service is insignificant or the information was not available.

TABLE 2-44

REVENUES BY SOURCE
FISCAL 1977-78
(in dollars)

County City	Property tax	Intergovernmental revenue and transfers from other funds 3/	Licenses and permits	Charges for services	Fines and forfeits	Revenue by source sales taxes	Other tax revenue (specific ownership, etc.)	Refunds and surplus carry-over	Miscellaneous revenue	Total
Moffat	911,615	1,543,638	1/	1/	1/	1/	1/	1/	686,925	3,142,178
Craig	239,488	13,000	25,000	10,500	15,000	540,000	114,000	1/	40,012	983,500
Dinosaur	3,406	5,170	480	10,667	1,000	6,200	1,365	13,278	300	41,866
Rio Blanco	1,135,793	67,886	5,200	111,000	0	2/	30,000	0	50,075	1,399,954
Meeker	47,960	22,500	14,354	55,000	2,200	900	76,540	106,114	6,872	332,440
Rangely	99,511	110,974	7,105	11,327	2,500	50,800	31,240	17,669	3,800	335,026
Routt	1,496,590	130,040	71,000	227,600	0	2/	60,000	1/	19,400	2,004,630
Hayden	65,451	42,781	5,686		6,300	1/	1/	1/	18,200	139,718
Oak Creek	12,568	23,280	1,020		1,841	14,829	3,662	1/	11,321	73,121
Steamboat Springs	284,019	102,505	5,900	8,209	36,500	845,000	226,800		11,746	1,521,079

1/ Although this governmental unit has this revenue source, the amount of the revenue received from this source was not identifiable in its 1977 budget.
2/ No sales tax.
3/ Intergovernmental revenue includes payment in lieu of taxes, mineral royalties and other forms of state and federal assistance.

TABLE 2-45

REVENUE BY SOURCE AS PERCENTAGE OF TOTAL REVENUES
FISCAL 1977-78

County City	Property tax	Inter-governmental and transfers	Licenses and permits	Charges for services	Fines and forfeit	Sales tax	Other tax revenue	Refunds and surplus	Miscellaneous revenue	Total revenue
Moffat	29	49							22	100
Craig	23	1	2	1	1/	55	11		7	100
Dinosaur	8	12	1	25	2	15	3	32	2	100
Rio Blanco	81	5	1/	8	0		2		4	100
Meeker	14	7	4	16	1	21	23	31	4	100
Rangely	30	33	2	3	1	15	9	5	2	100
Routt	75	6	3	11	0		3	2		100
Hayden	47	30	5		5				13	100
Oak Creek	18	37	2		2	20			15	100
Steamboat Springs	19	7	1/	1/	2	55	15		2	100

1/ Less than 1 percent.

TABLE 2-46

OUTSTANDING BONDED INDEBTEDNESS, DEBT
SERVICE PAYMENTS, AND LEGAL BONDING CAPACITY, 1977

Jursidiction	Total bonded indebtedness 1/	Annual debt service, 1977	Total debt subject to legal limit 2/	Legal debt limit 3/
Moffat County	33,000	16,000	33,000	904,000
Moffat County School District RE#1	15,000	15,000	15,000	12,049,000
Craig	155,000 4/		0	1,497,000
Dinosaur	0	0	0	30,000
Rio Blanco County	0	0		3,023,000
Rio Blanco School District RE#1	895,000	100,000	895,000	4,737,000
Meeker	922,000		0	587,000
Rio Blanco School District RE#4	155,000	155,000	155,000	35,570,000
Rangely	915,000		15,000	408,000
Routt County	0	0		1,549,000
Routt County School District RE#1	2,850,000	240,000	2,850,000	6,156,000
Hayden	130,000	45,000	0	239,000
Routt County School District RE#2	884,000	211,000	884,000	10,612,000
Steamboat Springs	3,223,000	352,000	2,963,000	3,430,000
Routt County School District RE#3	0	0	0	3,687,000
Oak Creek	175,000		0	123,000
Yampa				68,000

1/ Excluding special districts.
2/ Includes all bonded debt except debt incurred by incorporated municipalities for purpose of water system improvement.
3/ Legal debt limit for counties is defined as 1 1/2 percent of total assessed value; for cities as 30 percent of actual value (actual value is approximately 333 percent of assessed value); for school districts, 20 percent of assessed value.
4/ Excludes $100,000 debt owed to private lender.

severance tax (House Bill 706). This tax is levied on the gross income of metallic minerals and the oil and gas produced in the state. The plan is to create a local governmental Severance Tax Fund which will begin aiding local governments by 1981. At that time the fund is expected to have accumulated over 4.5 million dollars in revenue. Fifteen percent of this revenue will be distributed directly to local governments on the basis of proportion of employees in mining-related fields.

Intergovernmental revenue may provide relief from the current financial stress, but does not provide the financial security which is essential for long-range planning. Since the energy production does not occur within the jurisiction of the municipalities, they have not been able to draw much direct revenue from the energy products. This has placed them at a relative disadvantage because they provide services for a large number of the energy employees.

Colorado State Finances. Three state revenue generating items (sales tax, income tax paid by employees, and mineral royalties resulting from coal mining) are considered in this report. Present estimates (1977) of the contribution from the study area to state revenues for each of the items respectively are $5,268,608, $4,287,748, and $4,373,578. Thus, the total estimated contribution from these three sources to state revenue in 1977 was $13,929,934.

Utilities. The Colorado-Ute Electric Association, a rural electric association, distributes electricity to about half of Colorado, including the Yampa Valley and White River Electric Associations which serve parts of northwest Colorado. The company estimates that new power plants will be needed to meet the rising demands of its thirteen member companies (Hoving, personal communication, 1977). Guaranteed sources of long-term coal and water are needed in order for the power plants to be feasible.

Western Slope Gas Company sells natural gas to the two gas distribution companies in northwest Colorado--the Greeley Gas Company, serving Craig, Meeker, and Steamboat Springs, Hayden, and Milner, and the Town of Rangley Gas Department, serving Rangely. Current demand for natural gas is almost at pipeline capacity. Before undertaking construction to increase pipeline capacity, the Western Slope Gas Company will re-evaluate its population projections to be assured they are realistic and that the large capital investment in pipeline construction is necessary (Peters, personal communication, 1978). Pipeline construction is not expected before 1979. In the short run, there may be facility constraints to meeting natural gas demands because two to three years are required for pipeline capacity to be increased.

Community Attitudes.

This section is based on previous social profiles and impacts studies of northwest Colorado as well as a series of informal interviews with informed local sources (e.g., politicians, clergy, etc.). Previous social profiles and impact studies conducted in northwest Colorado have stressed

the "traditional" values of its residents (NWCCRES). These values include conservatism, emphasis on strong family ties, the desire for self-sufficiency, the value of hard work, a high level of social conformity, and admiration of rugged individualism. Nevertheless, people living in the study area have been experiencing the same pressures for social change that have swept the rest of the nation. A number of energy booms have further affected the area and have attracted outsiders with different value systems. The study area has changed and is still changing; it is not a closed and static community.

This dichotomy between "traditional" and "new" values exists in most communities in the study area depending on the degree to which they have experienced recent population growth due to energy-related employment, tourism, or recreation. At one extreme are communities like Craig and Steamboat Springs, which recently have experienced rapid population growth and where effects of this cultural heterogeneity are most clearly seen. On the other hand, in small communities such as Dinosaur and Yampa values of the long-time conservative residents remain the dominant. Meeker, Rangely, Oak Creek, and Hayden fall into the middle of this spectrum.

Recognition of Past Energy Development. Most of the respondents were aware that energy development and related growth is not new to the area. Rangely and Meeker experienced oil shale development 80 years ago while more recently, in 1945, oil and gas development has occurred. The study area also has experienced coal mining, uranium mining and power plant construction.

Because of their past experience with energy development, informants in Craig, Steamboat Springs, Hayden, and Rangley reported that their communities were again experienceing a boom. (A "boom" was defined by respondents as occurring when population growth outstripped available housing and social services). Yampa, Oak Creek, Meeker, and Dinosuar respondents indicated that these communities are at a "tipping point", where additional growth will create boom conditions.

Previous booms have occasionally left local communities deeply in debt for community service facilities as the boom faded and the population declined. The small permanent population had to assume the debts, which were difficult to pay with a limited tax base. As a result, people are apprehensive about a boom-bust cycle and one major consequence is the repeated refusal of the communities to pass bond issues for community development.

Support for Energy Development. In every community respondents expressed support for energy development. The informants were aware of the negative aspects of energy development such as congestion, strain on housing and community services, increased crime and delinquency, and inflation but indicated that past development has been good for the area. Specifically, the availability of jobs has permitted residents to upgrade their occupations and has allowed the young people to remain in the area. The increased population has attracted more business and services to the community.

A survey of Meeker (Rio Blanco County Planning Department 1975) revealed that 80 percent of its citizens desired population growth in order to strengthen the tax base and economy of the community. Also, when the costs are weighted against the benefits, most informants replied that development has had positive impacts and that they will support continued development. For example, in a study of Craig (Grace & Company 1975) 45 percent felt that the benefits of the most recent boom had outweighed the costs, while only 23 percent felt that the costs were higher. The other 32 percent either felt they balanced out or had no opinion.

In addition, most of those interviewed reported that they feel that development is inevitable and will occur regardless of the feelings of the local residents. This is consistent with the alienation and possessiveness reported in an earlier study (NWCCRES). The people are very much aware of the energy crisis that faces this county and accept the idea that coal, gas, oil, and uranium resources of the area will have to be developed.

Desire Controlled Development. While the residents favor continued development and feel that it is inevitable, they do not support rapid, uncontrolled growth. Most reported that they favored a gradual expansion of energy development so that the impacted communities would have more time to absorb the additional population and to provide residents with the necessary community services. When asked to indicate the degree of growth that should be permitted under "controlled conditions", the usual reply was that it would depend on how much assistance the communities received in order to prepare for increases in population. According to the informants, the degree of energy development was related to community development. In other words, an area is ready for additional energy development as soon as housing catches up to demand, as new schools are built, as municipal water supply systems are completed, as water treatment plants are constructed, as hospitals are expanded, and as additional police and firemen are hired.

In contrast to the traditional values of rugged individualism and anti-government sentiment, most informants favored federal grants as the means for community development. The community leaders, in particular, stressed the need for grants without matching funds requirements or other stipulations. The respondents felt that massive federal assistance, while inconsistent with other community values, is justified because the entire nation is reaping the benefits of energy development. Also, the federal tax burden was used as a common justification for federal assistance. Respondents felt that the government "owes us" something anyway. Community leaders appeared to be very knowledgeable about federal sources of assistance including HUD, EPA, EDA, CETA, and Farmers' Housing and Drought Assistance. The larger communities like Craig, Steamboat Springs, and Rangely seemed confident that they would receive substantial federal assistance while the smaller communities were rather pessimistic about their chances for receiving such assistance.

An earlier study by the BLM indicated a preference for industry and state government assistance in dealing with energy development. When the same

area was surveyed three years later, however, interviews indicated a strong preference for the federal government assuming the major responsibility, with state government and private industry playing a secondary role in this process.

In summary, there is a general attitude among community residents that past energy development and associated growth has been good for the area. The costs have been high, but overall the benefits appear to outweigh them. There is support for future development and growth, but there should be time and assistance to prepare for it. It is felt that federal and state assistance is the only feasible way for the communities to prepare to provide community services for the rapidly expanding population which is likely to occur with extensive energy development.

Transportation Networks

Highways

The area is served by narrow two-lane paved highways designed primarily for lightweight traffic. The only major road is U.S. Highway 40, a widened two-lane highway, running east-west through Craig between Denver, Colorado, and Salt Lake City, Utah (Maps 2-7 and 2-8 show traffic volumes in the area). In 1976 there were 25,781 vehicles registered in the three counties of the study area. Traffic congestion on U.S. Highway 40 occurs at shift changes at the Hayden Power Plant and at construction shift changes at the Craig Power Plant.

Colorado 13 between Meeker and Craig, the main north-south route, is not heavily traveled and currently is being used by three coal companies (Empire-Energy, Colowyo, Sewanee). Only the stretch from Axial to Craig is suitable for heavy truck traffic. The portion of Colorado 13 from Axial 10 miles to the south is subjected to extensive frost-snow damage each spring and early summer. Colorado 13 has virtually no shoulder adjacent to the paved strip north of Craig; vehicles drop off the edge of the driving lane, resulting in many accidents each year.

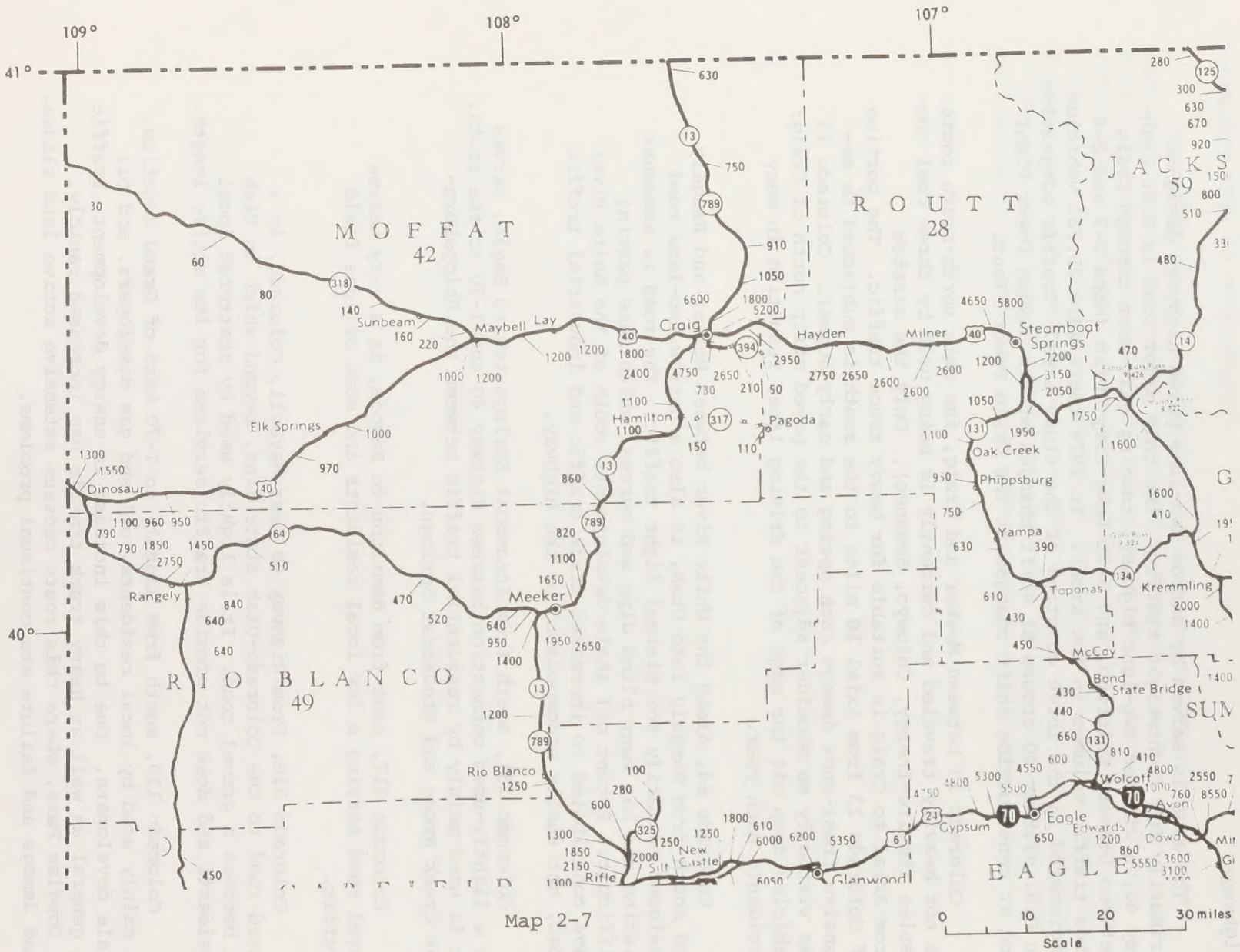
Colorado 64, along the White River between Meeker and Rangely and north from Rangely into Utah, is also a narrow two-lane road designed primarily for minimal light traffic. The road is somewhat winding and has many blind dips and curves, which make passing difficult. Recent oil shale developments south of the White River have contributed to increased truck traffic and industrial traffic load, not easily accommodated by the highway.

Colorado 131, south from Steamboat Springs toward Eagle, serves as a lightly-used connection between Highway 40 and I-70 to the south. It is used mainly by residential traffic between the Phippsburg-Oak Creek areas and Steamboat Springs.

Colorado 317, east from Hamilton to Pagoda, is a very narrow paved road serving a few local residents and some oil-gas field traffic.

Colorado 318, from Highway 40 near Maybell, Colorado, is a paved road to the Colorado-Utah state line, beyond which in Utah it becomes a gravel road. It is lightly used by scattered local residents and does not provide traffic services for its entire length.

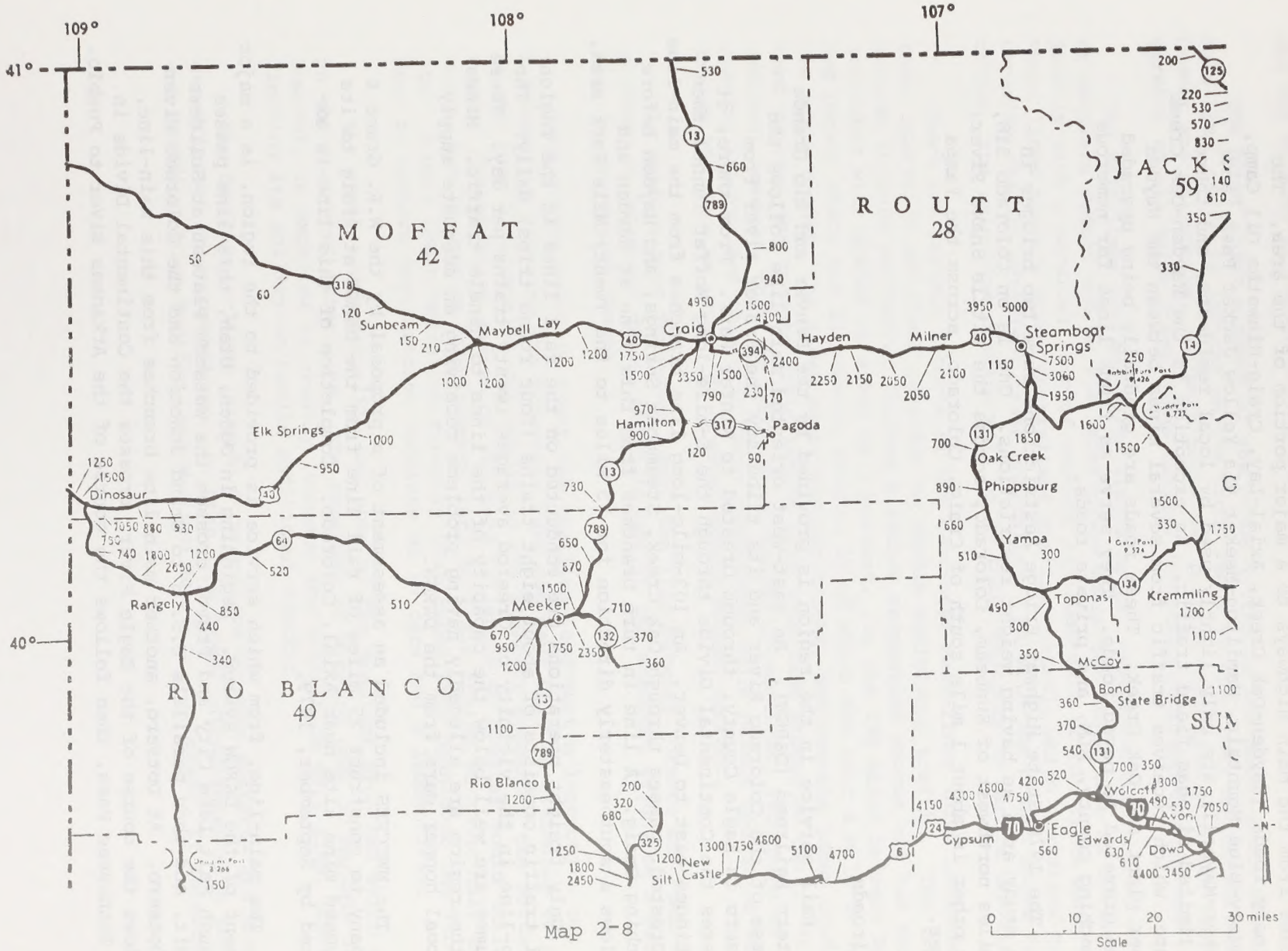
Colorado 139, south from Rangely to I-70 west of Grand Junction, is mainly used by local residents, oil and gas developers, and oil shale developers. Due to this increase in energy development, traffic in general as well as heavy truck traffic has increased rapidly. At Douglas Pass, where this route crosses extensive active land slides, road damage and failure are continual problems.



Map 2-7

Average Daily Traffic (ADT) Volumes - 1976

SOURCE: Colorado Division of Highways



Map 2-8

Average Daily traffic (ADT) volumes - 1974.

SOURCE: Colorado Division of Highways

County roads in Routt, Moffat, and Rio Blanco Counties provide access from the main highways to a major portion of the area. The primary roads (Hayden-Oak Creek, Axial-Lay, Craig-Hiawatha Oil Camp, Rangely-Blue Mountain, Hamilton-Meeker via Yellow Jacket Pass, and Meeker-Maybell) are only lightly used by local residents, and there is limited oil-gas field traffic. An exception is the Hayden-Oak Creek route, which receives traffic from several mines between the Hayden power plant and Oak Creek. These roads are gradually being upgraded from graveled to paved roads. They serve as trunk lines for numerous branching county, BLM, and private roads.

The 1978 State Highway Bridge Restrictions show two bridges in the study area as having weight restrictions. One is on Colorado 318, 9 miles northwest of Sunbeam, Colorado, across the Little Snake River; the other is about 1 mile south of Craig, Colorado, across the Yampa River.

Railroads

Rail service in the region is provided by the Denver and Rio Grande Western Railroad (D&RGW). An east-west oriented main-line follows the course of the Colorado River and its tributary the Fraser River from Dotsero in Eagle County, through Orestod to Winter Park. From there, it crosses the Continental Divide through the 6-mile-long Moffat Tunnel then continues east to Denver. An 102-mile-long line branches from the main-line at Orestod, passes through Oak Creek, Steamboat Springs, and Hayden before reaching Craig. A line in turn branches from this line at Hayden and follows a southeasterly direction for 13 miles to the Twenty Mile Park area.

Only freight operations are conducted on the rail lines in the region; coal traffic consists of about eight trains (four round trips) daily. The main-line in the vicinity of Orestod averages twenty trains per day. These volumes are well below the capacity of the lines to handle traffic. Mines in the region are allegedly having problems receiving an adequate supply of coal hopper cars from the D&RGW.

The NWCCRES included an assessment of a proposal by the W.R. Grace & Company to construct 25 miles of rail line from the D&RGW at Craig to its proposed mine site near Axial, Colorado. Completion of this line is expected by September, 1979.

The main-line, from which service is provided to the region, is a major element of the D&RGW system. Beginning in Ogden, Utah, this line passes through Salt Lake City and Provo, crosses the Wasatch Plateau at Soliders Summit, and then parallels U.S. 6 to Grand Junction and the Colorado River at Dotsero. At Dotsero, another main-line branches from this main-line, follows the course of the Eagle River, crosses the Continental Divide in the Tennessee Pass, then follows the course of the Arkansas River to Pueblo.

A convenient connection does not exist between the Dotsero to Denver and the Dotsero to Pueblo main-lines.

The other major element of the D&RGW system is its north-south oriented main-line, which is located on the front range of the Rocky Mountains between Denver and Walsenburg. Between these two points, this line provides rail service to all major front range cities, including Colorado Springs and Pueblo.

The main-lines are generally single track, except for limited stretches at Soldiers Summit and on the front range where the D&RGW line is operated jointly with a parallel line of another railroad as a double track line. These lines operate under Centralized Traffic Control, which maximizes track capacity through efficient train scheduling. As with the branch lines in the region, the main-line operate well below their capacity to handle traffic.

There are certain aspects of the east-west main-lines which influence their operation and their capacity to handle additional traffic. The line between Dotsero and Denver follows a rather serpentine course and has short stretches with grades as steep as 2 percent. In the 130 miles between Bond and Denver there are 22 passing tracks, 15 of which are over a mile in length. The steep grades, the seven short passing tracks, and certain labor conditions tend to keep the average train length over this line around 80 cars. It is assumed, however, that the addition of helper locomotives, lengthing of the passing tracks, and change in labor conditions could permit operation of trains 100 cars in length or greater should demand warrant.

In passing over Tennessee Pass, the line between Dotsero and Pueblo must surmount a 3 percent grade, which is one of the steepest grades on a main-line in the United States.

Such grades severely limit the trailing load that a locomotive can handle. A locomotive crossing the Tennessee Pass can haul only an estimated 60 percent of the load a locomotive can handle on the steepest grades of the Moffat Tunnel route. Conceivably, trains of 100 cars in length or greater could utilize this route, but locomotive requirements tend to limit trains to about half this length. A unit train operation recently instituted from Utah over the Tennessee Pass to eastern destinations consists of 50 cars and 5 locomotives.

The north-south main-line has none of the gradient problems which exist on the east-west main-lines. The movement of Wyoming coal to markets in Texas, however, is expected to greatly increase the traffic on this line, thereby limiting its ability to handle additional traffic.

The D&RGW main-lines provide a connection between western- and midwestern-oriented rail operations. In Utah, the D&RGW interchanges with the Southern Pacific, Union Pacific, and Western Pacific. In Denver, it interchanges

with the Burlington Northern, Union Pacific, and Rock Island; in Colorado Springs with the Rock Island; and in Pueblo with the Santa Fe and Missouri Pacific. The north-south main-line, which is operated jointly with the Santa Fe between Denver and Pueblo, provides the only north-south rail link through this portion of the front range.

The D&RGW system provides the only rail service to many of the existing coal producing areas of Utah and Colorado, including the Central Utah Coal Region and the West Central Colorado Coal Region. Both are served by the same main-line, which provides service to the northwest Colorado coal region.

The closest point to the region served by another railroad company is Hebron in Grand County, approximately 30 miles by road over Buffalo Pass from Steamboat Springs. This town is the terminus of a 107-mile-long branch line of the Union Pacific Railroad, which joins the main-line at Laramie, Wyoming.

Airlines and Bus Lines

Steamboat Springs and Craig are served by daily scheduled airline service from Denver by Rocky Mountain Airways. Yampa Valley Airport at Hayden is served by Frontier Airlines on a route connecting Denver-Hayden-Rock Springs-Vernal and Salt Lake City. The Yampa Valley Airport is currently undergoing an expansion and improvement program. Rangely and Meeker airports have no scheduled flights by any airlines.

Continental Trailways bus line and Wilderness Transit bus line provide for the scheduled bus service through the study area. Continental Trailways provides for stops in the study area on its east-west Denver-Salt Lake City runs at Dinosaur, Elk Springs, Maybell, Lay, Craig, Hayden, Milner, Steamboat Springs, Oak Creek, Phippsburg, Yampa, and Toponas. Craig serves as a connection depot for the east-west Continental Trailways bus line and the southbound Wilderness Transit bus line. Craig is the northern end of the line for Wilderness Transits' Craig-Grand Junction run, with one other stop in the study area, at Meeker. Rangely has no bus service.

FUTURE ENVIRONMENT WITHOUT ADDITIONAL DEVELOPMENT OF FEDERAL COAL

The following section describes the future environment without the additional development of federal coal beyond "low-level" (existing development of state, private, and federal coal), described in Chapter 1. This description is based on the following assumptions:

1. All discussion in this section will be based on the same time-frame of analysis to the year 1990.

2. The principal determinant for future conditions is the existing development of coal, which is a dominant factor in the economy of the study area. All future conditions will be predicted on the basis of this development.

3. All impacts on future conditions due to recreational development, the other major economic factor in the study area, are, for the purposes of this analysis, considered minor in relation to coal development.

The projected continuation of existing coal production from federal and non-federal lands is shown in Table 8-1. Map 1-2 shows the location of the existing and future mining operations that will require no additional federal action. Total coal production, given no additional federal actions within this study area, would increase from the current 7,404,100 million tons per year, to 16,595,000 tons in 1980, and 18,195,000 tons in 1985. However, by 1990, production would decrease to 15,870,000 tons. This decrease would be due to a reduction in production from non-federal lands. Federal production would remain about level, at around 5 million tons.

Table 8-2 shows the projected cumulative development with no additional federal coal, which is the same as the low-level, analyzed in Chapter 8. By 1990, there would be 14 new mines, 760 megawatts of new power plant capacity, a population increase of 13,200, 42.5 miles of new railroad; and 55 miles of new road over 1977 levels.

Table 8-5 shows other data associated with the continuation of existing coal development. By 1990, a total of 18,910 acres would be disturbed due to coal mining and associated development above that in 1977, and a total of 10,070 acres would have been reclaimed, leaving some 8,840 acres permanently removed from current land uses. Approximately 73 percent of this permanent removal would be due to secondary impacts such as population increases in the study area, and development of permanent transporation facilities such as roads and railroads.

Employment in coal production would increase from the 1977 level of 1,013 to 1,565 in 1980, 2,200 in 1985, and then remain nearly stable through 1990 at 2,110. The proportion of employment in federal mines would remain fairly constant, around 400 employees, through 1990. Therefore, it can be seen that the greatest level of activity in the future would be on non-federal coal lands. Overall population increases would be 800 by 1980, 11,600 by 1985, and 13,200 by 1990.

Annual water requirements for coal production activities would increase to 510 acre-feet in 1980, and 550 acre-feet in 1985, and decrease slightly by 1990 to 490 acre-feet. The greater proportion of water requirements would be for non-federal coal production and handling. By far the greater water requirements in the study area will be due to population increases. Annual water requirements would be expected to increase to 1,050 by 1980, and 1,480 by 1985, and stabilize through 1990 at 1,420 acre-feet.

Other trends for the future environment can briefly be summarized. Subsidence effects would not threaten any existing structures or public roadways. In the absence of specific mining plans, the magnitude of subsidence cannot be predicted. Paleontological resources would continue to be effected so long as mining continues within the study area. Some resources could be lost, but others could be recovered for study and thereby provide beneficial information for future research.

Ground water aquifers would continue to be effected. Effects of mining activity include removal of parts of certain aquifers, interruption of pre-mining ground-water flow, modification of flow by replaced spoils materials, and the effects of subsidence from underground mining. By 1990, the total

area of aquifers removed would be about 34 square miles, or 0.4 percent of the shallow ground-water aquifers in the study area, as summarized in Table 8-6.

Disturbance of stream channels by 1990 would take place on only 0.34 percent of the study areas. Natural stream channels would be altered or removed within the areas disturbed by continued coal development.

Coal mining operations would slightly increase the consumptive use of water in the report area and, consequently, would reduce discharge downstream. In 1990, continuation of the existing coal development would deplete the annual water yield from the Yampa River subbasin by about 1.3 percent, an insignificant amount.

Increased municipal wastes, leaching of spoil materials, and water pumped from mines into streams as a result of continued development would slightly degrade water quality in the report area by 1990. A total of 9,000 tons of dissolved solids from municipal wastes and mining activities would enter the Yampa River annually, compared to 429,000 tons from other sources, principally from natural leaching of salts and irrigation activities. The increase in dissolved solids concentration in the Colorado River below Hoover Dam attributable to continued development would be about 0.9 mg/l, or about 0.1 percent of the current load. Any increase, even this small, is considered a significant impact in the region. The increase in weighted average of dissolved solids in the Yampa River would be 19.2 mg/l by 1990 from all sources. About 5.0 mg/l or 26 percent of this amount would be attributable to municipal wastes and mining activities.

Changes in sediment yield stemming from surface disturbances directly and indirectly associated with coal mining in the study area with continued development would range widely depending on required mitigation measures. If as effective as anticipated, these measures should reduce total sediment yield associated with coal development about 10 percent below premining rates. This represents a decrease over previous years, principally due to reclamation of much of the area disturbed during 1978-85 and to limitation of suspended solids in runoff from mined and reclaimed areas due to implementation of applicable rules and regulations. Existing rules and regulations, however, generally do not apply to activities stemming indirectly from coal mining such as housing construction and related urbanization. Increased sediment yield from these sources would be virtually unmitigated and could locally impact receiving streams.

There is no indication that the future climate of northwest Colorado through 1990 would differ significantly from that which exists today.

Maximum ambient levels of total suspended particulates (TSP), SO_2, NO_2, CO, and non-methane hydrocarbons (NMHC) would result from continued development at low-level. Highest pollutant levels would be centered about major towns in the study area (Craig, Steamboat Springs, and Meeker), but concentrations would drop almost to rural baseline levels within 5 to 15 miles from the towns.

As population increases, pollutant levels around towns in the study area would also increase, principally due to local vehicular traffic, residential and commercial space heating, building construction, and other municipal development. The portion of this increase resulting from coal development at existing mines would be insignificant.

Railroads serving continued development would produce pollutant emissions, but they would be intermittent and their impact is expected to be site-specific. Fugitive dust from the construction of additional lines should be small and have no significant effect on regional TSP concentrations.

Ambient TSP levels in the vicinity of existing mines should not significantly increase above existing levels and should not significantly affect air quality of major towns in the study area. Although there would not be a significant increase in non-methane hydrocarbons (NMHC) with continued development in the study area, the existing baseline concentration already exceeds the air quality standard and would continue to exceed it.

Uranium mining and the development of oil shale and geothermal resources would not significantly affect the future environment because relatively little is expected from these activities in the study area.

The detailed analysis of the future air quality is presented in the low-level scenario of Chapter 8.

Surface disturbance of soils due to continued coal development would involve 18,910 acres by 1990. Soils permanently lost due to mining and particularly due to related activities would involve 4,110 acres by 1990.

Continued coal development will result in the temporary loss of vegetative production of 3,410 AUMs (rangeland) by 1990, with a premanent loss of 770 AUMs. Removal of vegetation while the mines are in active operation would cause loss of the diverse vegetation, as well as loss of production, and the increased pressures on adjacent areas by livestock and wildlife. Disturbance of wildlife habitat by 1990 would involve 18,910 acres. Of this, 8,290 acres would be elk habitat, 1,300 would be antelope habitat, 5,000 acres would be sage grouse habitat, and all 18,910 acres would be deer habitat. Acres of habitat permanently lost by 1990 would be 4,110 due to the continuation of present coal development. Of this, total acreage permanently lost, all 4,110 would be deer habitat, 1,880 acres would be elk habitat, 290 acres would be antelope habitat, and 1,100 acres would be sage grouse habitat. Destruction of this sage grouse habitat would result in total loss of sage grouse because of the critical habitat of their strutting grounds. Other animal losses due to destruction of habitat would be about 25 percent, that is, a loss of 20 elk, 2 antelope, in addition to the 80 sage grouse.

Degradation of aquatic habitat and water quality from continued coal development would be short-term and localized, principally around existing towns and developments. By 1990, a total of 245 acres of aquatic habitat would be lost, which is a relatively small amount of total existing habitat.

However, the population increases anticipated would place pressures on the capacities of existing waste water treatment plants, possibly resulting in discharges of effluent into water ways and increases in nutrient levels in streams below major population areas such as Craig and Meeker.

Continued mining would be concentrated in areas where sites dating from 5,000 years ago through historic times are located. Loss of data through casual collection or loss of or damage to sites may bias prehistoric reconstruction within the study area and for the Northwestern Plains area. However, since all required surveys have not been completed, loss and damage cannot be assessed quantitatively. One site, designated 5RT32, has been recommended for nomination to the National Register of Historic Places (NRHP). By 1990 it would be subjected to surface collection. From past surveys, 37 sites are recorded in areas of continued development. Four of these sites, 5MF435, 5MF444, 5MF681, and 5RT32, are eligible to NRHP. By 1990, the numbers of sites directly affected by existing and continued mining cannot be determined, but losses due to community expansion and surface collection may decrease when expansion stops and population growth tapers off.

There are no known historic sites that would be destroyed as a result of continued mining on federal lands by 1990. However, continued surface mining development on state and private lands would cause displacement of historic sites, as would population growth in population centers such as Craig, Meeker, Hayden, and Steamboat Springs. Appendix A, Section 4, lists specific sites that could be affected.

Impacts to visual resources with continued development of coal at low-level have not been assessed, but areas most vulnerable to adverse impacts can be generally indicated. They are: Eastern Routt County: the area visible from U.S. 40, Colorado 131, and the Hahn's Peak Road; in the Mount Harris area, lands visible from U.S. 40; Williams Fork Mountains: the landscape visible from U.S. 40, Colorado 13, and the Williams Fork road; lands on the periphery of Axial Basin; in the Meeker area, landscapes visible from Yellowjacket Pass, Ninemile Gap, and the Wilson Creek Oil Field as well as the pastoral and agricultural lands east of Meeker and the lands near the National Forest Boundary.

Increases in recreation demand and some losses of recreation resources, would result from continued coal development. Because 4,110 acres would be permanently lost by 1990 due to coal mining activities, there would be a loss or disruption of some areas considered important for their natural and wildlife values, or for their mood-atmosphere qualities (cultural and visual resources). There would also probably be increased use of off-road vehciles, vandalism, illegal artifact and fossil collecting, crowding of recreation areas adjacent to mining areas, and trespass problems. Increases in recreation needs would be proportional to population growth, by 1990 increasing 9,070 over 1975 for a total population of 33,956, an increase of 36 percent.

Following completion of Colorado-Ute Electric Association's Craig Power Plant near Craig and the subsequent layoff of most of the present 1,420-man construction workforce, there would probably be a large out-migration of construction workers unable to find alternative local employment.

The cessation of power plant construction expenditures and related expenditures by construction worker households would cause additional contraction of the local economy, giving rise to additional unemployment and out-migration.

Craig is projected to shrink back to a population of 4,100 by 1980 in the absence of further coal development to absorb the laid-off construction workers. Due to its role as a regional agriculture and trade center, Craig is expected to gradually regain population, but by 1990 would still have only 6,200 inhabitants, or 7 percent less than its 1977 population.

Moffat County's population would also show the results of the decline in Craig, dropping precipitously from 10,313 in 1977 to 7,800 by 1980, then slowly growing to 9,900 by 1990. The county's only other incorporated municipality, Dinosaur, is expected to grow from 347 in 1977 to 500 by 1985 as a result of construction of the U-a/U-b oil shale operation in neighboring Utah, then decline to 460 as U-a/U-b's large construction workforce is replaced by a smaller permanent staff.

Rio Blanco County is expected to grow from 5,100 to 13,900 inhabitants by 1985, fueled by moderate growth in the county's oil and gas production and especially by constuction of three large oil shale projects on the C-a, C-b and Superior oil shale tracts. Both the towns of Meeker and Rangely would share in the county's rapid population growth through 1985, expanding from 1,848 to 8,400 and 1,871 to 4,100, respectively, in just 7 years. However, following completion of the three oil-shale plants by 1985, Meeker and Rangely face short-term population declines of 800 to 300 inhabitants, respectively.

Routt County is expected to expand continuously between 1977 and 1990, from 10,516 to 16,200 inhabitants, under the combined impetus of the coal mining, tourism and recreation industries. Oak Creek faces a short-term population decline by 1980 as a result of completion of the Craig Power Plant, but over the long term, Hayden and Oak Creek should grow from 1,362 to 3,000 and 756 to 1,200, respectively, due to the influx of coal mine workers and workers from Steamboat Springs. Steamboat Springs itself, with its expanding year-round recreation industry, is expected to grow from 4,028 to 7,600 permanent residents. Yampa would also expand somewhat, from 307 to 360 residents.

With continuing development, regional population is forecast to increase over 50 percent, form 25,929 to 39,000, by 1990. The present population distribution would change somewhat. That part of the population living in "urban" areas (incorporated places over 2,500 inhabitants plus adjacent settled areas) would grow from 10,705, or 41 percent of the population in 1977 to 28,200, or 72 percent of the population. By 1990, Meeker, Rangely, and Hayden would join Craig and Steamboat Springs as "urban" areas under the census definition.

With continuing development at low-level, total wage and salary earnings in Moffat County are projected to decline from $73.2 million to $49.9 million (1976 dollars) with completion of the Craig Power Plant and subsequent construction worker layoffs. This would lead indirectly to a contraction in trade and services earnings. In the absence of additional coal development,

Moffat County wage and salary earnings are expected to increase gradually from a 1980 low, by 1990 to $62.9 million (14 percent below 1977 levels).

Development of Rio Blanco County's oil shale resources would have a large impact on the wage structure of the local economy. Total earnings would increase from $23.8 million in 1978 to $133.3 million in 1985 before declining to $115.6 million in 1990, as the large oil shale construction force would be replaced by a smaller operating work force. By 1990, Rio Blanco County would depend on the mining sector (oil, gas, oil shale) for over 70 percent of total earnings.

Routt County would experience substantial growth in mining earnings under continuing development at low-level (from $7.4 million in 1977 to $18.7 million in 1990, an increase of 154 percent), but this growth would not lead to a large dependence on mining, which would account for only 23 percent of the county's total wage and salary earnings.

The status of transportation networks by 1990 with continued coal development would be affected chiefly by (1) transportation of coal out of the study area, and (2) increased employment and population, with its corresponding increase in vehicles and miles-traveled.

With continued development of coal, by 1990 most of the existing highways would be severely taxed as a result of an increase in population. Many of these highways need to be upgraded and improved presently, because they were not designed for industrial hauling which has and would continue to occur with expansion of coal mining, oil and gas development, and oil shale projects.

According to the Colorado Department of Highway's Draft Five Year Highway Construction Plan for Fiscal Years 1979-1983, several highway improvement projects are presently proposed, which are summarized in Chapter 8, Transportation Networks.

According to Table 8-40, average vehicle-miles per day would increase by 30 percent, to 685,000 by 1990. Vehicle registrations in Routt, Moffat, and Rio Blanco Counties would increase from 25,781 in 1976 to 48,500 by 1990.

Train traffic in the region is expected to increase by 9 percent, to 1,590 trains per year, by 1990. Other than the 12.5 miles of new rail spur to Peabody's Moffat Mine, the study area's railroad system would be upgraded as discussed in Chapter 1, Transportation Developments. Oil Shale developers consider rail service essential to their plans. Superior Oil favors a high-speed rail line from Piceance Creek up to the Union Pacific system in Wyoming over the slower D&RGW system into Denver. By 1990, railroad crossing hazards would generally increase due to increased rail service (Table 8-44).

SUMMARY FEATURES OF EXISTING AND FUTURE ENVIRONMENT

Following is Table 2-47, which summarizes the features of the existing and future environment described in Chapter 2.

TABLE 2-47

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT

Environmental Element	Existing Environment (1978)	Future Environment (1990)
Geologic Setting Topography	Broad open plains of altitude 5,200-7,700 feet. Drainage westward by White and Yampa Rivers.	Permanent disturbance of land for ancillary development and housing. By 1990, a total of 4,560 acres. Temporary disturbance of land for mining, to be progressively reclaimed (see Vegetation). By 1990, a total of 14,800 acres. Subsidence and tension cracks, primarily where long-wall method used in underground mines. Not quantifiable.
Stratigraphy	Coal beds only in strata of Iles and Williams Fork formations of Late Cretaceous Age and Fort Union formation of Tertiary Age. Terrestrial environs: sandstones, siltstones, and sandy shales.	
Structure	Complex structure of anticlines and synclines.	
Geomorphology	Subdued, with fairly steep scarp slopes and moderated steep dip slopes; landslides can occur. Streams superimposed on ridges, hills, etc.	
Paleontology	Fossils found in most of the sedimentary rocks in the study area.	Loss of plant, invertebrate, and vertebrate fossil materials for scientific research and public education, etc., through mining. Not quantifiable. Exposure of fossil materials for scientific examination and collection. Not quantifiable. Loss of paleontological materials due to unauthorized collecting and vandalism. Not quantifiable.
Mineral Resources Coal	Three coal fields: Yampa: subbituminous; Danforth Hills: complex geology, high-volatile C bituminous Lower White River: high-volatile C bituminous and non-coking.	Removal of coal, a total of 224,680,000 tons by 1990. See Table 8-2 for other projections related to coal development. Unrecovered coal due to losses inherent in mining methods; 50 percent recovery by underground, 90 percent by surface mining methods. A total of 79 million tons would not be recovered by 1990.
Other Minerals	Many formations in the study area contain oil and gas. Areas of exploration are shifting from anticlinal traps to fault and sedimentary traps; conflicts with coal development are therefore greater, although resources normally can be recovered sequentially from the same place (see NWCCRES, p. II-9).	Conflicts in mineral development: oil and gas vs. coal rarely occur; coal vs. uranium not known at this time. Sequential recovery normally employed. Impacts not quantifiable.
Water Resources Ground Water	Ground-water recharge on the high interstream areas tends to percolate downward to the first relatively impermeable layer, then mostly downdip or laterally towards bordering valleys. Ground-water movement downdip impeded, so recharge in interstream areas discharged along nearby valley side slopes. Top of zone of saturation in coal areas at level of perennial streams in bottoms of principal stream valleys that transect the dipslope surfaces. Above this level, ground water found within 100 feet of surface; this often drains down into unsaturated coal and sandstone beds.	Removal of parts of certain aquifers and dewatering of mines would lower water levels locally, resulting in the loss of a few springs.

TABLE 2-47

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT (Cont.)

Environmental Element	Existing Environment (1978)	Future Environment (1990)
Water Resources (cont.)		
Ground water (cont.)	Below the zone of saturation, ground-water typically occurs under confined conditions; wells on valley floors more than 200 feet deep flow at land surface.	
	Coal beds may be drained above top of zone of saturation; below it, they are potential water-bearing rocks.	
	Greatest contribution of ground-water flow to streams is in south and eastern parts of coal area, where precipitation is lowest. Total contribution of ground-water to runoff in total coal area: about 4,000 acre-feet (0.3 percent of annual water yield of area). Considering evapotranspiration losses, contribution even more insignificant (less than 1 percent of total dissolved solids yielded by rivers annually in report area).	
Surface water	Surface runoff varies directly with amount of precipitation, highest in eastern coal tracts, lowest in western.	
	Conversely, highest peak discharges in west where runoff generated by high-intensity storms; eastern runoff due mostly to snow melt.	
	Water yield from coal tracts only 1 percent of total for report area.	Reduction in flow to Lower Basin States. By 1990, reduction would not be significant.
	Most streams draining coal tracts have small peak discharges, except near Rangely.	
	Runoff from coal tracks about 43,000 acre-feet/year, dissolved solids of 53,000 tons/year (18 percent of that yielded by Yampa River subbasin).	Dissolved solids concentration in Colorado River below Hoover Dam attributable to coal development: any increase would be significant because current levels exceed desirable limits. By 1990, coal development would account for an increase of 7.0 mg/l.
	Suspended sediments yield to principal streams from central and eastern tracts probably very small. No data for western tracts, but much higher there.	
	Identification of alluvial valley floors: no data but on-going farming implies their existence, in the lower reaches of most perennial and some intermittent stream valleys in the Yampa and Danforth Hills coal fields. None apparently exist in the arid Lower White River coal field.	
Climate	Geographical and meteorological complexity: climatic conditions vary widely within short distances. Mountains of the Continental Divide provide barrier to moisture-laden air that reaches into the Great Plains from the Gulf of Mexico. Temperatures: cold in winter and, except for higher elevations, warm in summer. Precipitation derives mostly from Pacific air and occurs mostly during the summer half of the year. Considerable snowfall occasionally accompanies low pressure storms. Prevailing winds are westerly over the higher elevations and highly dependent on the valley orientation in the lower valleys.	There is no indication that the future climate of northwest Colorado through 1990 would differ significantly from that which exists today.
Air Quality	Class I areas as defined by the 1977 federal Clean Air Act Amendments (visibility cannot be impaired) include the northern tip of the Flat Tops Wilderness Area and the western part of the Mount Zirkel Wilderness Area. The Dinosaur National Monument has been similarly designated under Colorado standards. The area within the city limits of Craig does not meet primary federal total suspended particulate (TSP) standards. Rio Blanco County does not meet federal standards for	At continued development at low-level, maximum allowable levels under federal and state standards would result from total suspended particulates, SO_2, NO_2, CO, and non-methane hydrocarbons, principally around major towns due to local vehicular traffic, heating, construction, and other municipal development. Concentrations would drop almost to rural baseline levels within 5 to 10 miles from town. That portion of this increase

TABLE 2-47

SUMMARY TABLE OF EXISTING AND FUTURE ENVIRONMENT (Cont.)

Environmental Element	Existing Environment (1978)	Future Environment (1990)
Air Quality (cont.)		Railroads serving continued development would produce pollutants, but these would be site-specific and intermittent. Fugitive dust from construction of additional lines should be insignificant. There would be no significant increase in total suspended particulates and non-methane hydrocarbons in the vicinity of mines that would continue to operate at low-level, but the existing baseline concentrations already exceed the existing air quality standards and would continue to exceed them. Uranium mining and the development of oil shale and geothermal resources would not significantly affect future air quality because little is expected from these activities in the study area through 1990.
Soils	Soil associations for the study area are described in Chapter 2. Reclamation potentials are variable, are better if slopes gentler, soils deeper, finer, less clay textures, fewer salts, more moisture, longer growing season. U.S. Department of Agriculture, Soil Conservation Service, is conducting a detailed survey within the study area; initial surveys show much variation in soil physical and chemical properties.	Surface disturbance: see Topography. Soil productivity would be permanently lost on soils permanently disturbed, temporarily lost on soils temporarily disturbed. Naturally developed soil horizons, structure, parent material, soil micro-climates, permeability, and infiltration rates would all be lost or reduced on all disturbed soils, by 1990 a total of 19,360 acres. Loss of exposed soils by wind and water erosion. Not quantifiable. Loss of soils due to ORV use; see Recreation. Not quantifiable but would increase proportional to population.
Vegetation	Nine primary and two secondary vegetative types (as classified in BLM Manuals 9160-1962). Sage, mountain shrub, and pinyon-juniper are the major vegetative types affected in the study area (Table 2-22). Moisture is often the dominant limiting factor for distributuion of vegetation. Vegetation studies have not been in depth sufficient to determine locations of threatened or endangered species.	Removal of vegetation principal impact of ongoing mining: See Togography. Reclamation (regrading to original contour and revegetation) of temporarily disturbed soils; by 1990, a total of 10,070 acres. Unavoidable temporary loss of production on temporarily disturbed soils (cumulative loss by each date). By 1990, a total of 10,980 AUMs. Permanent loss of production on permanently disturbed soils (expressed as rate of loss per year). By 1990, 850 AUMs/year. Loss of vigor and diversity, successional stage. Time to reestablish vegetative ecosystem would be long-term: 20 to 50 years. Over utilization of adjacent areas by wildlife and domestic fauna; impact would be localized, not quantifiable.
Animals Wildlife	Big game: cougar, black bear, mule deer, elk; white-tail deer, pronghorn antelope. Winter range is limiting factor for survival of these species. Study area contains some critical winter range.	Because of mining, some destruction of habitat, displacement of game animals, roadkills; destruction of less mobile species, but not significant.

TABLE 2-47

SUMMARY OF EXISTING AND FUTURE ENVIRONMENT (Cont.)

Environmental Element	Existing Environment (1978)	Future Environment (1990)
Animals (cont.)		
Wildlife (cont.)	Sage grouse is main upland game bird in the study area.	
	Sage grouse, mule deer, elk, antelope hunted extensively within the study area.	
	Four species on U.S. Department of Interior's list of endangered fauna inhabit the area: peregrine falcon, black-footed ferret, whooping crane, and bald eagle. Two more on State of Colorado's endangered species list: river otter and greater sandhill crane.	Threatened and endangered species not affected by on-going mining.
Domestic Fauna	In recent years, livestock operation shifting from sheep to cattle. Presently, 112,500 cattle and 200,000 sheep in the study area.	
	Domestic and wild horses found in the study area.	
	Most operations rely on native range to winter livestock; winter forage is limiting factor to livestock operations in the study area.	Loss of production, temporary and permanent (see Vegetation).
	Competition may exist for food, water, cover, and living space among domestic and wild animals.	
Aquatic Biology	Eastern half of the study area has both cold and warm water habitat for fish.	
	Blue-ribbon trout fishing areas: Steamboat Springs, Hayden, Oak Creek, Yampa, and Hahn's Peak, and Williams Fork River.	By 1990, permanent loss of 275 acres of aquatic habitat due to disturbance of land; would not affect blue-ribbon game fisheries.
	Area east of State Highway 13 between Wyoming border and Meeker and west to the Routt National Forest are fair-to-good trout fishing areas.	
	The western half of the study area has mainly warm water fisheries, occurring mainly on the Yampa and White Rivers.	
	Endangered Species:	
	The Colorado River squawfish occurs in portions of the White and Yampa Rivers, especially the segment of the Yampa from its confluence with Milk Creek to the Green River.	
	The Humpback chub occurs in the White and Yampa Rivers. Both are on the U.S. List of Endangered Fauna and the Colorado List of Endangered Species.	
	The Humpback sucker (on the Colorado List of Threatened Species) and the bonytail chub (on the Colorado List of Endangered Species) also occur in the White and Yampa Rivers.	
Cultural Components		
Archeological Resources	In the study area, survey and excavation have been concentrated in Dinosaur National Monument. There, Fremont Culture documented and older sites similar to those identified as of the Desert Culture and Plains Archaic also found.	Uncovering of archeological materials and inventorying and recording of sites otherwise not discovered, but materials lost for application of better archeological analysis methods developed in future.
	Adjacent to the study area, a sample survey completed in Piceance Basin and complete surveys made in Canyon Pintado National Historic District and for the Savery Pot Hook Reservoir area.	Casual collection would result in loss or mixing of diagnostic data used to interpret interrelationships between prehistoric peoples and their environments. Loss cannot be assessed.
	Therefore, within the study area, spatial distribution of cultures and people is in descriptive stage. Regional chronology has not been formulated; dates for sites are extended from selected sites in Utah	

TABLE 2-47

SUMMARY TABLE OF EXISTING AND FUTURE ENVIRONMENT (Cont.)

Environmental Element	Existing Environment (1978)	Future Environment (1990)
Cultural Components (cont).		
Archeological Resources (cont.)	Difficult to determine exact cultural affiliation during an initial survey. Also, surveys in the study area have been undertaken primarily because of contemporary development (surveys for rights-of-way, etc.) and do not reflect prehistoric occupation and utilization nor site density within the study area.	Loss of unidentified surface and buried sites where community expansion would occur. Loss cannot be assessed. Loss of paleoecological data on federal and non-federal leases. Loss cannot be assessed.
	Of sites surveyed to date, 37 recommended for nomination to the National Register of Historic Places (NRHP). They exist in areas of potential coal development and are listed in Table 2-23. More sites eligible to NRHP.	Loss or disturbance of recorded and unidentified surface or buried sites in lease areas and rights-of-way. Loss cannot be assessed.
	Four NRHP sites on federal lands adjacent to the study area could be affected indirectly by future development: vandalism, etc.	Loss of archeological resources because of subsidence above underground mines. Loss cannot be assessed.
Historic Resources	Forty-four NRHP sites recorded in the study area; 15 older sites in the study area do not appear to qualify for NRHP (list in Appendix A, Section 4).	Increased vandalism of historic sites. Loss cannot be assessed. Destruction of "historic atmosphere" in towns where older structures displaced by new construction. Loss cannot be assessed.
Aesthetics	Landscape character described in Aesthetics. Areas generally affected: eastern Routt County: the area visible from U.S. 40, Colorado 131, and the Hahn's Peak Road; in the Mount Harris area, lands visible from U.S. 40; Williams Fork Mountains: the landscape visible from U.S. 40, Colorado 131, and the Williams Fork road; lands on the periphery of Axial Basin; in the Meeker area, landscapes visible from Yellowjacket Pass, Ninemile Gap, and the Wilson Creek Oil Field as well as the pastoral and agricultural lands east of Meeker and the lands near the National Forest boundary.	Impacts to landscape character: (1) support facilities for new population, (2) mining on steep slopes, (3) surface facilities not blending with landscape, and (4) construction of roads, railways, and electric distribution lines on steep terrain or bedrock material contrasting with surrounding landscape. Impact cannot be assessed, but areas generally affected are listed under Existing Environment. Dust, pollution, and noise would adversely affect aesthetic quality of general area. Impact cannot assessed.
Recreation	Three river segments within the study area being considered for inclusion in the National Wild and Scenic Rivers System: segments of the Elk River, Green River, and Yampa River. Ecological features: a pinyon-juniper relic area, pinyon trees in Skull Creek area, and a ponderosa pine relic area on Douglas Mountain. Primitive-natural values: Mount Zirkel Wilderness Area and Flat Tops Wilderness Area, both on National Forest Lands. Ten wildland tracts in western part of study area being considered as wilderness study areas. Existing recreation developments: Routt and White River National Forests, Dinosaur National Monument, Brown's Park National Wildlife Refuge, Steamboat Lake State Park. Colorado Division of Wildlife (DOW): Service Creek, Indian Run, and Bel Air campgrounds and Cristina picnic ground. DOW and BLM maintain six primitive hunter camps on Cold Springs Mountain. Also, DOW: four water-based recreation areas - Ralph White Reservoir, Lake Avery, Elkhead Reservoir, and Rio Blanco Recreation Area. Also, fishing leases on the White and Elk Rivers. Colorado Division of Highways: one rest stop. Municipal-county: five city parks, four semi-private nine-hole golf courses, and 30 other recreation areas. Also, facilities associated with schools.	With increases in population, increases in coliform levels (see Aquatic Biology) on White and Yampa Rivers; Yampa could be ineligible for designation under Wild and Scenic Rivers Act. Also, possible curtailment or prohibition of water-contact sports. Mining provides human-interest and educational opportunities. Increased use of developed recreation sites in study area. With disturbance of land for mining and ancillary construction (see Topography), loss of foot, ORV, and viewing opportunities. Subsidence could also be hazardous to these activities after reclamation. Deficiencies in swimming, golf, and tennis opportunities in Routt and Moffat Counties, hunting opportunities in Routt County would increase with population.

TABLE 2-47

SUMMARY TABLE OF EXISTING AND FUTURE ENVIRONMENT (Cont.)

Environmental Element	Existing Environment (1978)	Future Environment (1990)
Cultural Components (cont.)		
Recreation (cont.)	Private recreation: 121 private recreation areas: hunting and fishing areas, campgrounds, picnic grounds, dude ranches, and recreation resorts. Three ski areas. Nine private lease areas, chiefly for hunting and fishing for American Sportman's Club and the International Sportman's Club. Hunting: small game - cottontail rabbit, dove, blue grouse. Big game: deer, elk, bear, and antelope.	
Socio-Economic Environment	Demographics: Region's population primarily rural. Between 1970 and 1977, a significant increase in the proportion of 20-24 and 25-34 year-olds, reflecting influx of young, primarily male mining, oil field, and construction workers as well as younger people of both sexes attracted by Steamboat Springs resort activity.	
	Between 1970 and 1975, all three counties showed population growth: Moffat due to coal-related development, Rio Blanco because of new oil discoveries, and Routt due both to renewed coal mining activity and continued expansion of Steamboat Springs. Except for Rio Blanco, whose population declined after the oil boom passed its peak, these trends have continued from 1975 to the present.	Craig projected to decline in population after completion of Craig Power Plant and absence of further coal development to absorb laid-off construction workers. Craig would gradually regain population by 1990, but it would be 7 percent less than in 1977. Moffat County's population would reflect this, dropping from 10,313 in 1977 to 7,800 by 1980, then increasing to 9,900 by 1990. Rio Blanco County would grow 5,100 in 1977 to 13,900 by 1985 due to growth in oil and gas production and especially construction of three large oil shale projects (C-a, C-b, and Superior); after completion of these projects in 1985, a short-term decline. Routt County would expand continuously from 10,516 in 1977 to 16,200 in 1990 due to expansion of coal mining, tourist, and recreation industries.
	Employment (1977): Mining (coal, oil shale, gas) is fairly evenly distributed among the three counties, varying from 8 to 9 to 26 percent in Moffat, Routt, Rio Blanco Counties, respectively. The great concentration of construction workers in Moffat County (30.1 of total employment v. 8.8 and 10.7 in Rio Blanco and Routt, respectively) is due to construction of the Craig Power Plant (Units 1 and 2). Trade, finance/real estate/insurance, and services account for nearly half of total employment in Routt County due to recreation and tourism in the Steamboat Springs area. Employment by state and local government proportionally large: from 18.2 to 26.4 percent of total employment in each of the three counties.	
	Unemployment: Since 1975, Moffat and Routt Counties have both had relatively high unemployment rates, in 1977 8.0 and 7.9 percent. In Moffat County, this was due to influx of persons anticipating employment in the services sector as a result of future coal-related development. In Routt County, this was due to large number of young people seeking employment in the Steamboat Springs resort area.	
	Income (1977): In Rio Blanco County, oil and gas major source of income - 33.8 percent. In Routt and Moffat Counties, coal mining similarly important (17.0 and 11.3 percent), but eclipsed by construction (20.6 and 44.9 percent), making these areas economically vulnerable to fluctuations in construction, like completion of Units 1 and 2 of the Craig Power Plant in Moffat County. Mining and construction, along with federal government, were also highest paying sectors.	Following completion of Colorado-Ute Electric Association's Craig Power Plant and layoff of most of the present workforce, a large out-migration of construction workers unable to find alternative local employment. An accompanying contraction of local economy after early 1980s.

TABLE 2-47

SUMMARY TABLE OF EXISTING AND FUTURE ENVIRONMENT (Cont.)

Environmental Element	Existing Environment (1978)	Future Environment (1990)
Cultural Components (cont.) Socio-Economic Environment (cont.)	Investment patterns (1977): Construction, and then coal, were highest private investments. In terms of local governments' property tax base, only county governments and school districts in which they were located experienced direct impacts. Municipalitites had to provide public facilities and services to new population generated by these investments, but property tax bases increased only indirectly, from additional assessments on employees' homes and associated commercial development. Community Attitudes (1977). "Traditional" values predominate at the moment, but pressure for change, due in part to energy-related development, tourism, and recreation which have attracted outsiders with different values. The conflict of values exists predominantly in communities that have experienced recent, large population growth (Craig, Steamboat Springs). In every community, people generally felt benefits of energy development outweigh the costs. Support controlled growth, federal and state assistance as a means of community development.	Without additional development of federal coal, total wage and salary earnings in Moffat County are projected to decline from $73.2 to $49.9 million with completion of the Craig Power Plant (early 1980s), leading indirectly to contraction in trade and services earnings. But, wage and salary earnings would increase gradually after that, reaching $62.9 million (14 percent below 1977 total earnings) by 1990. Total earnings in Rio Blanco County are projected to increase $23.8 million in 1978 to $133.3 in 1985 before declining to $115.6 million in 1990, reflecting completion of the large oil shale construction and by 1985. Despite no additional development of federal coal, Routt County would experience substantial growth (from $7.4 to $18.4 million from 1977 to 1990), but would not lead to a large dependence of mining relative to total wage and salary earnings (23 percent).
Transportation Networks Highways	Area served by narrow two-lane paved highways designed primarily for lightweight traffic. Principal roads: U.S. Highway 40 (east-west) and Colorado 13 (north-south), both running through Craig. Colorado 64, between Meeker and Rangely and north from Rangely into Utah; designed for minimal light traffic. Colorado 131, south from Steamboat Springs toward Eagle; minimal light traffic. Colorado 317, east from Hamilton to Pagoda; narrow paved road for minimal light traffic. Colorado 318, from Highway 40 near Maybell; minimal light traffic. Colorado 139, south from Rangely to I-70 west of Grand Junction; rugged, narrow road, frequently badly in need of repair. Heavy traffic from oil and gas developers. County roads in Routt, Moffat, and Rio Blanco Counties: lightly used; limited oil-gas field traffic.	Roads designed for lighter traffic would receive heavy use due to coal mining, oil and gas development, and oil shale projects; deterioration hastened (see Tables 1-3 through 1-6). According to the Colorado Department of Highway's Draft Five Year Highway Construction Plan for Fiscal Years 1979 to 1983, several highway improvement projects are proposed, summarized in Chapter 8, Transportation Networks. Average vehicle-miles per day would increase by 30 percent over 1977, to 685,000 by 1990 in the study area (Table 8-40).
Railroads	Railway freight service provided by Denver and Rio Grande Western Railroad from Denver to railhead at Craig. No passenger service. Longest train possible: 84 cars of 100-ton capacity. Coal hopper cars in short supply in the study area.	Train traffic in the region would increase by 9 percent, to 1,590 trains per year by 1990. The study area's railroad system would be upgraded (Chapter 1, Transportation Developments). Oil shale developers consider rail service essential, Superior Oil favors a high-speed rail line from Piceance Creek up to the Union Pacific system in Wyoming over the slower D&RGW system into Denver. By 1990, railroad crossing hazards would generally have increased due to increased rail service (Table 8-44). Daily vehicle-waiting time for the study area would also increase.
Airlines and Bus Lines	Steamboat Springs and Craig served daily by Rocky Mountain Airways from Denver. Frontier Airlines serves Yampa Valley Airport at Hayden. Continental Trailways and Wilderness Transit bus lines provide scheduled bus service through the study area.	

CHAPTER 3

PLANNING AND ENVIRONMENTAL CONTROLS

This chapter presents the planning and environmental controls that would apply to possible future mining and related activities. It consists of three sections: (1) a discussion and analysis of principal planning and environmental legislation and regulations which control federal, state, and local government action with their respective applications to coal development; (2) a discussion of land use plans, controls, and constraints; and (3) a summary discussion of institutional relationships.

LEGAL, REGULATORY, AND POLICY FRAMEWORK

COAL RESOURCES

The two laws that provide the basic authorities for leasing and management of federal minerals, including coal, are the Mineral Leasing Act of 1920 (41 Stat. 437, as amended; 30 USC 181 et seq.) and the Mineral Leasing Act for Acquired Lands (61 Stat. 913; 30 USC 351-359).

Recent passage of the Federal Land Policy and Management Act (FLPMA) of 1976, P.L. 94-579, (90 Stat. 2743; 43 USC 1701-1771) has given the BLM a mandate to retain public lands for multiple-use management. In addition, FLPMA has given BLM the authority to carry out comprehensive land use planning to be used in decision-making, has abolished or consolidated a number of old public land laws, and authorizes BLM to promulgate regulations and policy governing all aspects of public land management. Basically, the law consolidates existing authorities in one document and ensures that the public lands remain open for location of mining claims, for public hunting, fishing, camping, and other outdoor recreation, for the production of natural resource products, and for authorization of rights-of-way.

Laws applying to coal leasing and development are implemented by the Bureau of Land Management (BLM), the U.S. Geological Survey (USGS), and the Office of Surface Mining (OSM) under the following regulations:

Title 43 CFR 3041 sets forth regulations governing reclamation standards; use of surface; bond requirements; and reports relating to leases and licenses issued by the BLM with respect to federal coal deposits located on public and acquired lands of the United States and reserved deposits underlying lands the surface of which is privately owned. In effect, the regulations allow BLM to exert its environmental protection responsibilities while ensuring orderly development of the federal coal deposits. It provides procedures to ensure that adequate

measures are taken during exploration or mining of the federal coal to avoid, minimize, or correct damages to the environment (land, water, and air) and to avoid, minimize, or correct hazards to public health and safety.

Title 43 CFR 3500 provides procedures for leasing, licensing, and subsequent management of federal coal (among other minerals) deposits.

Title 43 CFR 2800 and Title V of FLMPA establishes procedures for issuing rights-of-way to private individuals and (or) companies on public lands. These regulations provide authority for identifying and protecting environmental resources that could be affected by right-of-way construction for coal-related projects.

Title 30 CFR 211 governs operations for discovery, testing, development, mining, and production of federal coal under leases and licenses in accordance with 43 CFR 3500. The purposes of the regulations in 30 CFR 211 are to promote orderly and efficient operations and production practices without waste or avoidable loss of coal or other mineral-bearing formations; to encourage maximum recovery and use of coal resources; to promote operating practices which will avoid, minimize, or correct damage to the environment, including land, water and air, and avoid, minimize, or correct hazards to public health and safety; and to obtain a proper record of all coal produced.

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) (P.L. 95-87; 91 Stat. 447; 30 USC 1201 et seq.) regulates the surface mining and surface effects of underground mining of all coal deposits and is implemented by the Office of Surface Mining under the regulations in 30 CFR 700. The Act and regulations provide for environmental performance standards for surface coal mining and reclamation operations; inspection and enforcement procedures, including the assessment of civil penalties; requirements and approval procedures for state programs; requirements for surface coal mining and reclamation operations on public lands; procedures for state and federal designation of areas unsuitable for surface and (or) underground coal mining operations; requirements and procedures for approval of state mining permits; and requirements for posting, release, and forfeiture of performance bonds.

Recently adopted federal regulations of the Office of Surface Mining Reclamation and Enforcement, 30 CFR 700, along with previously adopted federal regulations concerning mining, 30 CFR 211, and Rules and Regulations of the Colorado Mined Land Reclamation Board would mitigate many of the impacts which would otherwise occur to the geologic and geographic setting.

The regulations found in 30 CFR 700 differ from the previous 30 CFR 211 regulations in that they are more specific in the area of mitigating the impacts on the topography due to surface mining.

Rules and Regulations

Mining

1. Mining on slopes greater than 20 percent. Title 30 CFR 716.2 deals with mining on slopes greater than 20 percent and states that spoils shall not be placed or allowed to remain on the downslope. The highwall shall be completely covered with spoil and the affected area graded to the approximate original contour, as provided in 30 CFR 715.14. This regulation will protect the affected area and the area downslope from the mining operation.

Reclamation

1. Restoration to original contour. Title 30 CFR 715.14 states that to achieve the approximate original contour the permittee shall transport, backfill, compact (where advisable to ensure stability or to prevent leaching of toxic materials), and grade all spoil material to eliminate all highwalls, spoil piles, and depressions. With this mitigation, 30 CFR 715.13 (a), which states that " . . . all disturbed areas shall be restored in a timely manner (1) to conditions that are capable of supporting the uses which they were capable of supporting before any mining or (2) to higher or better uses. . .," will be attained. Disturbed areas will be restored to their approximate original contour.

2. Mountain top removal. Mountain top removal is covered in 30 CFR 715.14 (c) and 716.3. These regulations state in part that if an operator removes entire coal seam(s) in the upper part of a mountain, ridge, or hill, the area need not be restored to approximate original contour, but that all highwalls, spoil piles, and major depressions shall be eliminated. The final graded top plateau slopes shall be less than 20 percent. With these mitigating measures the affected areas can be returned to a post-mining use which is as good or better than the pre-mining utility as stated in 30 CFR 715.13 (a).

Other applicable federal (30 CFR 211) and state regulations concerning the geologic and geographic setting can be found in Chapter IV, NWCCRES, Regional Analysis. Regulations contained in 30 CFR 211 include those concerned with maximum resource recovery and minimum damage to remaining mineral resources (211.4(b and c)); prevention of damage to significant scientific values (211.4(d)(9)); subsidence (211.31(a and c)); hazardous conditions (211.4(d)(7)); returning land to its approximate original contour (211.40(a)(2)); and stabilization of slopes to avoid landslides (211.40(a)(3)). Compliance would be the responsibility of the Office of Surface Mining (OSM) in consultation with the USGS and District Manager (BLM) or other surface management agency.

Paleontology

BLM and the U.S. Geological Survey are currently developing a Memorandum of Understanding concerning protection of paleontological resources on federal lands.

This memorandum will indicate technical guidelines to define the resource, evaluatory criteria, and measures for protection. When completed, the memorandum will provide a basis for management and protection of paleontological resources.

The following rules and regulations (Table 3-1) would wholly or partially mitigate most impacts to the water resources stemming from surface and underground mining in northwestern Colorado. Arranged in order of importance, they are:

TABLE 3-1

SUMMARY OF IMPORTANT WATER RESOURCES RULES AND REGULATIONS

Rules and Regulations	Authority	Applicability
30 CFR 700 (Federal Register, vol. 42, no. 239, December 13, 1977)	Surface Mining Reclamation and Enforcement Act - Public Law 95-87 (91 Stat. 447; 30 USC 1201 et seq.) August 3, 1977	Federal, state and fee coal
30 CFR 211 (Federal Register, vol. 41, no. 96, May 17, 1976)	Pursuant to regulations in 43 CFR 3500 and the Alaska Coal Leasing Act of October 20, 1914, as amended (38 Stat. 741; 48 U.S.C. 432-445)	Federal coal
43 CFR 3041 (Federal Register, vol. 41, no. 96 May 17, 1976)	Mineral Leasing Act of February 25, 1920, as amended (30 U.S.C. 181-287) and the Mineral Leasing Act for Acquired Lands (30 U.S.C. 351-359)	Federal coal leases
Colorado Regulations Rules 1-8	Colorado Mined Land Reclamation Act of 1976, C.R.S. 1973, 34-32-101 et seq., as amended (1976 Sess. Laws, Ch. 108)	Federal, state and fee coal

In addition to the above rules and regulations, all waters in the report area are subject to provisions of the Federal Water Pollution Control Act (FWPCA), as amended in 1972, and all surface waters are subject to basic water quality standards for Colorado adopted January 15, 1974, pursuant to section 66-28-202 (b) and section 66-28-208 C.R.S., 1963, as amended.

Mitigating effects of specific rules and regulations are summarized in the following sections:

Rules and Regulations

General

1. Hydrologic balance. The permittee must plan and conduct surface and underground coal mining and reclamation operations to minimize disturbance of the prevailing hydrologic balance in order to prevent long-term adverse changes that could result both on- and off-site (30 CFR 715.17 and 717.17).

Disturbances to the prevailing hydrologic balance of the affected land and of the surrounding area and disturbance to the quantity of water in surface and ground water systems both during and after the mining operation and during reclamation shall be minimized by measures such as:

a. Compliance with applicable Colorado water laws and regulations governing injury to existing water rights;

b. Compliance with applicable federal (EPA) and Colorado water quality laws and regulations;

c. Compliance with applicable federal (Corps of Engineers) and Colorado dredge and fill requirements;

d. Removing temporary or large siltation structures from drainways after disturbed areas are revegetated and stabilized, if required by the reclamation plan; and

e. In all mining operations, minimizing disturbance to hydrological functions of alluvial valley floors of affected lands and surrounding areas (30 CFR 700; Colorado Regulations, Rule 6.1 a).

The operator must take such actions as may be needed to minimize, control, or prevent (1) soil erosion; (2) pollution of surface or ground water; and (3) serious diminution of the normal flow of water (30 CFR 211.4 (d)).

Applications to the Bureau of Land Management (BLM) for a coal lease or license must contain a brief description of the proposed measures to be taken to control, or prevent soil erosion and pollution of surface and ground water (43 CFR 3041.1-2 (b)(2)(V)).

2. Water rights. The permittee must replace the water supply of an owner of interest in real property who obtains all or part of his supply of water for domestic, agricultural, industrial, or other legitimate use from an underground or surface source where such supply has been

affected by contamination, diminution, or interruption proximately resulting from surface or underground coal mine operations by the permittee (30 CFR 715.17 (i) and 717.17 (i)).

The operator must provide an estimate of project water requirements and indicate the water rights or sources of water to supply these project water requirements. If the development, mining, and reclamation phases of the project are expected to cause measurable, material injury to senior water rights, the operator must describe the steps to be taken to resolve the injury to such water rights (Colorado Regulations, Rule 7c,d, and f).

3. Alluvial valley floors. Coal mining operations in and adjacent to alluvial valley floors must be planned and conducted so as to preserve the essential hydrologic functions of these valley floors. Mining must not interrupt, discontinue, or preclude farming on alluvial valley floors and shall not materially damage the quantity or quality of surface or ground water that supplies these areas unless premining use was undeveloped rangeland or unless the area of alluvial valley floor is small and provides negligble support for production from one or more farms. This exclusion does not apply to mines in production or having permits to mine on alluvial valley floors prior to August 3, 1977 (30 CFR 715.17 (j)).

4. Valley floors. No land within 100 feet of an intermittent or perennial stream shall be disturbed by surface or underground coal mining and reclamation operations unless specifically authorized by the regulatory authority (30 CFR 715.17 (d) (3) and 717.17 (d)).

The quality, quantity, and flow, including depth of flow, of upstream and downstream surface- and ground-water resources of those valley floors which provide water sources that support significant vegetation or supply significant quantites of water for other purposes shall be protected (43 CFR 3041.2-2 (f)(7)(iv)).

5. Diversion of water. Surface or ground waters shall not be discharged or diverted into underground mine workings (30 CFR 715.17 (h)).

6. Inspections. The Mining Supervisor must inspect coal mining operations to determine compliance with surface and ground-water management and pollution control measures required by applicable leases, permits, or licenses, and approved plans, and promptly notify appropriate representives of other federal and state agencies in the event of any noncompliance (30 CFR 211.3 (11)).

Ground Water

1. Protection of the hydrologic system. Surface and underground coal mining operations must be conducted so as to minimize adverse effects on ground water flow and quality, both on-site and off-site. The permittee

must monitor to ensure that operations conform to this requirement (30 CFR 715.17 and 717.17).

3. Restoration of recharge capacity. Reclaimed areas must be restored to approximate premining recharge capacity to support approved postmining land use and minimize disturbances to the prevailing hydrologic balance, both on-site and off-site. The permittee must monitor to ensure conformance with this requirement (30 CFR 715.17 (h)(1)).

4. Leaching of toxic pollutants. Backfilled materials must be selectively placed and compacted wherever necessary to prevent leaching of toxic pollutants into surface waters (30 CFR 715.14 (j)(2), 717.14 (a), 211.40 (a)(2), (8); 43 CFR 3041.2-2 (f)(2); and Colorado Regulations, 7.1 a).

5. Mixing of ground waters. Pollution or mixing of ground waters of significantly different quality shall be prevented by casing, sealing, or otherwise managing drill holes, wells, auger holes, shafts, etc. (30 CFR 715.17 (g)(5), 211.3 (9), and 43 CFR 3041.2-2 (f)(7)(i)).

6. Disposal of wastes. Waste materials from conversion facilities (power plants) and municipal wastes must be buried so as not to adversely affect water quality (30 CFR 715.14 (j)(3)).

7. Preblasting survey. Personnel approved by the regulatory authority shall conduct a preblasting survey to determine the condition of all wells or other water systems used for human, animal, or agricultural purposes and the quantity and quality of the water. A written report shall include recommendations of any special conditions or proposed adjustments to the blasting procedures to prevent damage to identified wells or water systems (30 CFR 715.19 (b)(2)).

8. Blasting. Blasting shall be conducted so as to prevent any change in the availability of ground or surface waters outside the permit area (30 CFR 715.19 (e)(2)(i)).

9. Use of wells by others. Upon receipt of a written request from the surface owner or the appropriate authorized officer, the Area Mining Supervisor may approve the transfer of an exploratory well for further use as a water well, subject to any state law requirements with respect to such transfer. Approval of such well transfer will be accompanied by a corresponding transfer of responsibility for any liability for damage and eventual plugging (30 CFR 211.21 (c)).

10. Monitoring. Ground-water levels, infiltration rates, subsurface flow and storage characteristics, and the quality of ground water shall be monitored in a manner approved by the regulatory authority to determine the effects of surface and underground coal mining and reclamation operations on the recharge capacity of reclaimed lands and on the quantity and quality of water in ground-water systems on-

site and in associated off-site areas (30 CFR 715.17 (h)(3) and 717.17 (h)(2)).

11. Permanent abandonment. Before permanent abandonment of coal exploration or mining operations, all openings and excavations, including water-discharge points, shall be closed or backfilled, or otherwise permanently dealt with in accordance with sound engineering practices and according to the approved plan (30 CFR 211.41 (c)).

Surface Water

1. Stream channels. Changes in the location of surface water drainage channels must be minimized so as not to adversely effect post-mining land use (30 CFR 715.17).

2. Stream channel diversions. Diversions of perennial and intermittent streams must be approved by the regulatory authority and must be in compliance with all federal and state statutes and regulations. New channels must maintain average stream gradients and remain stable to the extent possible using the best technology currently available (30 CFR 715.17 (d)(1)(i) and 717.17 (d)).

Channel and flood-plain configurations must be adequate to safely pass peak runoff from a precipitation event having a 10-year recurrence interval for temporary diversions and a 100-year recurrence for permanent diversions (30 CFR 715.17 (d)(1)(ii) and 717.17 (d)).

3. Diversion structures. All temporary diversion structures must be removed and the affected land reclaimed. When such structures are removed, all downstream water-treatment structures protected by these temporary diversion structures must be modified or removed to prevent failure (30 CFR 715.17 (d)(2) and 717.17 (d)).

4. Postmining use of land. The proposed postmining land use must not present actual or probable threat of water flow diminution or pollution (30 CFR 715.13 (d)(6)).

Proposals to change premining land uses of range, fish and wildlife habitat, forest land, hayland, or pasture to a postmining cropland use, where the cropland would require continuous maintenance to be practicable or to comply with applicable federal, state, and local laws, shall be reviewed by the regulatory authority to assure that sufficient water is available and committed to maintain crop production (30 CFR 715.13 (d)(9)(ii)).

5. Treatment of runoff. All water discharged from disturbed areas that violates federal or state laws or regulations must be treated by adequate facilities except for runoff from a 10-year 24-hour precipitation event or larger storm (30 CFR 715.17 (a)(2)).

6. Noxious substances. The operator must treat or dispose of all rubbish and noxious substances in a manner designed to minimize, control, or prevent water pollution (43 CFR 3041.2-2 (f)(8)).

7. Acid and toxic materials. Drainage emanating from acid-forming or toxic-forming mine waste materials and spoils placed on the land surface shall be avoided by burying or otherwise treating all toxic or harmful materials where necessary and by preventing water from contacting these materials (30 CFR 715.17 (g), 717.17 (g), 211.40 (a)(7), and 43 CFR 3041.2-2 (f)(7)(i)).

All exposed coal seams and any acid- or toxic-forming materials shall not be buried or stored near drainage courses or where they pose a threat of water pollution (30 CFR 715.14 (j)(1)).

8. Pollution control. Backfilled materials must be selectively placed and compacted wherever necessary to prevent leaching of toxic forming materials into surface or subsurface waters (30 CFR 715.14 (j)(2)).

Water pollution shall be minimized by using treatment methods where necessary such as stabilizing disturbed areas through grading, diverting runoff, achieving quick growing stands of temporary vegetation, lining drainage channels with rock or vegetation, mulching, selectively placing waste materials in backfilled areas, and using water-treatment facilities, if necessary (30 CFR 715.17).

9. Water quality standards and effluent limitations. Discharges from areas disturbed by surface and underground coal mining operations and reclamation activities conducted thereon must meet all applicable federal and state regulations and at a minimum the following numerical effluent limitations (Table 3-2).

Discharge from a precipitation event larger than 10-year 24-hour recurrence interval is not subject to the above effluent limitations (30 CFR 715.17 (a) and 717.17 (a)).

All surface waters in the report area are subject to basic water quality standards for Colorado adopted January 15, 1974, pursuant to section 66-28-202 (b) and section 66-28-204 C.R.S., 1963, as amended. The Yampa River and its tributaries, including the Williams Fork River, upstream from the mouth of the Williams Fork River must meet standards for class B1 waters (Appendix A, Section 6). Downstream from the mouth of the Williams Fork River, the Yampa River must meet standards for class B2 waters (Appendix A, Section 6). All tributaries and standing bodies of water in the report area listed in Appendix A of Water Quality Standards and Stream Classification for Colorado are classified as B1 waters, except Axial Basin Reservior, which is classified as B2 waters.

TABLE 3-2

EFFLUENT LIMITATIONS, IN MILLIGRAMS PER LITER (mg/l)

Effluent characteristics 1/	Maximum allowable	Average of daily values for 30 consecutive discharge days
Iron, total	7.0	3.5
Manganese, total	4.0	2.0
Total suspended solids	45	30

1/ These effluent constituents are generally not toxic to fish or other aquatic life at several times the limits indicated. Primary purpose of the limitations is to minimize filtration problesm at water-treatment plants downstream. Iron and manganese flocculents and suspended solids tend to clog filters and seriously reduce water-treatment capacity.

10. Dams constructed of or impounding waste material. No waste material shall be used in or impounded by existing or new dams without the approval of the regulatory authority. The permittee must design, locate, construct, operate, maintain, modify, and abandon or remove all dams constructed of waste materials in accordance with the requirements set forth in 30 CFR 715.18 (30 CFR 715.18 (a) and 717.18 (a)).

11. Impoundments. Earth dams, if necessary to impound water, may be constructed if such impoundments will not interfere with mining operations, damage adjoining property, or conflict with water pollution laws, or rules and regulations of federal, state or local governments (Colorado Regulations, Rule 6.2b).

12. Permanent impoundments. The permittee may construct permanent water impoundments on mining sites as a part of reclamation activities only when they are authorized by the regulatory authority and are adequately demonstrated to be in compliance with regulations governing the postmining use of the land and backfilling and grading in addition to the following requirements:

(1) The size of the impoundment is adequate for its intended purposes.

(2) Dam construction is designed to achieve necessary stability with an adequate margin of safety.

(3) The quality of the impounded water will be suitable on a permanent basis for its intended use and discharges from the impoundment will not degrade the quality of receiving waters below the water quality standards established pur-

suant to applicable federal and state laws.

(4) The level of water will be reasonably stable.

(5) Final grading will comply with provisions of 30 CFR 715.14 and will provide adequate safety and access for proposed water users.

(6) The impoundments will not result in the diminution of water used by adjacent landowners for agricultural, industrial, recreational, or domestic uses (30 CFR 715.17 (k), 211.40 (a)(5), and 43 CFR 3041.2-2 (f)(5)).

13. Discharge permit. If discharge occurs, the operator must obtain a National Pollutant Discharge Elimination System (NPDES) permit from the Water Quality Control Division at the Colorado Department of Health (Colorado Regulation, Rule 2.12 (7)(e).

14. Monitoring. The permittee must monitor all discharge from the disturbed area and from any underground operations. The monitoring program must provide adequate data to (1) describe the likely daily and seasonal variations in discharges in terms of flow, pH, total iron, total manganese, total suspended solids, and if requested by the regulatory authority, any other parameter characteristic of the discharge; and (2) determine normal and abnormal variations in concentrations. The program also must provide for analytical quality control including standard methods of analysis such as those specified in 40 CFR 136 (30 CFR 715.17 (b)(1), 717 (b)(1), and 211.4 (e)).

15. Water quality violations. Should any violations of permit conditions occur, the regulatory authority must be notified immediately after receipt of analytical results by the permittee (30 CFR 715.17 (b)(1)(v) and 717.17 (b)(1)(v)).

16. Monitoring discharge from reclaimed areas. The permittee must monitor surface water quality and flow from disturbed areas that have been regraded and stabilized to demonstrate that the quality and quantity of runoff without treatment will minimize disturbance to the prevailing hydrologic balance and permit the approved post-mining land use. These data provide a basis for approval by the regulatory authority for removal of water quality or flow control systems and for determining when reclamation requirements are met (30 CFR 715.17 (b)(2)).

17. Monitoring equipment. Equipment, structures, and other measures used to monitor runoff must be properly installed, maintained, and operated and must be removed when no longer required (30 CFR 715.17 (b)(3)).

Erosion Control

1. Sediment control measures, general. Appropriate sediment control measures must be designed, constructed, and maintained to prevent additional sediment from entering streams outside the permit area to the extent possible using the best technology currently available (30 CFR 715.17 (e), 717.17 (e), 211.40 (a) (3), 43 CFR 3041.2-2 (f)(7) (ii), and Colorado Regulations, Rule 6.1 b).

2. Topsoil handling. Topsoil must be segregated, and if not utilized immediately, must be stockpiled and protected from wind and water erosion (30 CFR 715.16, 717.20 (a), 211.40 (a)(4), and 43 CFR 3041.2-2 (f)(4)).

3. Slope stability. Backfilled materials must be selectively placed and compacted wherever necessary to ensure their postmining stability (30 CFR 715.14 (j)(2) and 717.14 (a)).

If not eliminated, all highwalls must be stabilized (Colorado Regulations, Rule 6.1 b).

Highwalls must be reduced to slopes not exceeding 50 percent or to such lesser slopes as the regulatory authority may specify (30 CFR 715.14 (g)(2)).

Highwalls must be eliminated in areas of adequate overburden by backfilling with suitable spoil and waste materials (30 CFR 715.14 (h)(5)).

Final graded slopes must not exceed approximate premining slopes. Lesser slopes may be specified by the regulatory authority (30 CFR 715.14 (b)).

Cut and fill terraces may be used on steep slopes to conserve soil moisture, ensure stability, and control erosion on final graded slopes (30 CFR 715.14 (b)(2)).

4. Stability of spoils placed outside mined areas. Such spoils must be placed on the most moderately sloping and naturally stable areas available. Fill materials must be placed on or above a natural terrace, bench, or berm, if such placement provides additional stability and prevents mass movement (30 CFR 715.15 (a)(2)).

Fills on slopes higher than 36 percent or on lesser slopes designated by the regulatory authority shall require keyway cuts to stable bedrock or rock toe buttresses to stabilize the fills (30 CFR 715.15 (a)(4)).

A system of underdrains must be installed along buried natural drainage systems to facilitate drainage and prevent saturation and

mass movement (30 CFR 715.15 (b)(6)).

Such spoils must be transported and placed in a controlled manner and concurrently compacted as specified by the regulatory authority to ensure mass stability (30 CFR 715.15 (b)(7)).

Terraces as specified must be constructed to stabilize the face of the fill (30 CFR 715.15 (b)(8)).

The tops of the fill and each terrace shall be graded no steeper than 5 percent and shall drain surface runoff to the sides of the fill where stabilized surface channels will carry water away from the fill (30 CFR 715.15 (b)(9)).

All surface drainage from the undisturbed area above the fill must be diverted away from the fill by approved structures leading into water courses (30 CFR 715.15 (b)(10)).

The outslope of the fill shall not exceed 50 percent. A flatter slope may be required by the regulatory authority (30 CFR 715.15 (b)(11)).

5. Mountain top removal. An outcrop barrier of sufficient width, consisting of the toe of the lowest coal seam and its associated overburden, must be retained to prevent slides and erosion (30 CFR 716.3 (b)(1)).

The final surface must be graded to drain inward from the outslope except at specific locations where water drains over the outslope in protected stable channels. Damage to natural water courses below the area mined must be prevented (30 CFR 716.3 (b)(3 & 4)).

The terms of a permit for mountain top removal may be modified by the regulatory authority if it determines that more stringent measures are necessary to prevent or control slides and erosion, prevent damage to natural water courses, avoid water pollution, or to assure successful revegetation (30 CFR 716.3 (c)(2)).

6. Sedimentation ponds. All surface drainage from disturbed areas (including reclaimed areas) must be passed through a sedimentation pond or a series of ponds before leaving the permit area unless the disturbed drainage area within the total disturbed area is small and the permittee shows that sedimentation ponds are not necessary to meet effluent limitations. Not included under this provision are areas where only diversion ditches, sedimentation ponds or roads are installed with no other disturbances upstream. Effluent limitations are listed under the previous section on Surface Water, Item 9. Sedimentation ponds must be retained until all water quality and revegetation requirements are met (30 CFR 715.17 (a) and 717.17 (a)).

Sediment removed from ponds shall be done so as to minimize adverse effects on surface waters downstream, on infiltration, on

vegetation, and on surface- and ground-water quality (30 CFR 715.17 (e)(6) and 717.17 (e)(6)).

All sedimentation ponds must be removed and the affected land reclaimed unless the regulatory authority approves permanent retention (30 CFR 715.17 (e)(10), 717.17 (e)(9), and 43 CFR 3041.2-2 (f)(7)(iii)).

7. Diversion structures. To minimize erosion and prevent water from contacting toxic-producing materials, overland flow may be diverted, if required or approved by the regulatory authority. Diversion would be away from disturbed areas by means of temporary or permanent diversion structures, provided that such structures be designed, constructed, and maintained in an approved manner so as to prevent additional contributions of suspended solids to stream flows outside the permit area to the extent possible, using the best technology currently available. In no event shall such contributions be in excess of requirements set by applicable state or federal laws (30 CFR 715.17 (c) and 717.17 (c)).

8. Discharge structures. Discharges from sedimentation ponds and diversion structures must be controlled, where necessary, using energy dissipators, surge ponds, and other devices to reduce erosion and prevent deepening or enlargement of stream channels and to minimize disturbances to the hydrologic balance (30 CFR 715.17 (f) and 717.17 (f)).

9. Roads. Access and haul roads and associated bridges, culverts, ditches, and road rights-of-way must be constructed, maintained, and reclaimed to prevent additional contributions of suspended solids to streamflow or to runoff outside the permit area to the extent possible using the best technology currently available. In no event shall the contributions be in excess of requirements set by applicable state or federal law. All such roads and associated structures must be removed and the affected area reclaimed unless retention of a road is approved as part of the postmining land use or is necessary to adequately control erosion and the necessary maintenance is assured (30 CFR 715.17 (l), 717.17 (j), 211.40 (a)(11), 211.41 (c), and 43 CFR 3041.2-2 (f)(11)).

All roads insofar as possible must be located on ridges or on the available flatter and more stable slopes to minimize erosion. Stream fords are prohibited unless specifically approved by the regulatory authority as temporary routes across dry streams. Other stream crossings must be made using bridges, culverts, or other appropriately designed structures. Roads must not be located in active stream channels nor can they be constructed or maintained in a manner that increases erosion or causes significant sedimentation or flooding (30 CFR 715.17 (l)(2)(i), 717.17 (j)(2)(i), 211.40 (a)(12)(ii), and 43 CFR 3041.2-2 (f)(12)(ii)).

To minimize erosion and subsequent disturbances to the hydrologic balance, roads must be constructed in compliance with established grade restrictions or other grades determined by the regulatory authority to be necessary to control erosion (30 CFR 715.17 (l)(2)(ii) and 717.17 (j)(2)(ii)).

All access and haul roads must be adequately drained using structures such as, but not limited to, ditches, water barriers, cross drains, and ditch relief drains. Water-control structures on access and haul roads to be maintained for more than one year must be designed to pass the peak runoff from a 10-year 24-hour precipitation event (30 CFR 715.17 (l)(2)(iii) and 717.17 (j)(2)(iii)).

Access and haul roads must be surfaced with durable nontoxic or nonacid-forming material. Vegetation may be cleared only for the essential width necessary (30 CFR 715.17 (l)(2)(iv) and 717.17 (j)(2)(iv), and 43 CFR 3041.2-2 (f)(12)).

Access and haul roads must be routinely maintained, and all structures serving to drain these roads must be kept clean so as not to impede drainage or adversely effect performance of the structures (30 CFR 715.17 (l)(3) and 717.17 (j)(3)).

10. Other transport facilities. Railroad loops, spurs, conveyors, or other transport facilities must be constructed, maintained, and reclaimed to prevent additional contributions of suspended solids to streamflows or to runoff outside the permit area to the extent possible, using the best technology currently available and to control other diminution or degradation of water quality and quantity. In no event shall contributions be in excess of requirements set by applicable state or federal law (30 CFR 715.17 (m) and 717.17 (k)).

11. Final grading. All grading must be done in a manner to control erosion and siltation of the affected lands to protect areas outside the affected land from slides and other damage. If not eliminated, all highwalls must be stabilized (Colorado Regulations, Rule 6.1 b, 30 CFR 715.14 (g)(2) and 715.14 (h)(3)).

All final grading, preparation of overburden before replacement of topsoil, and placement of topsoil must be done along the contour to minimize subsequent erosion and instability unless such final grading is hazardous to equipment operators. In all cases, grading, preparation, or placement must be conducted in a manner which minimizes erosion and provides a surface for replacement of topsoil which will minimize slippage (30 CFR 715.14 (k)).

Small depressions (less than 1 cubic yard) in the final surface may be approved by the regulatory authority to minimize erosion (30 CFR 715.14 (d)).

When rills or gullies deeper than 9 inches form in areas that have been regraded and the topsoil replaced but vegetation has not

yet been established, the permittee must fill, grade, or otherwise stabilize the rills and gullies and reseed or replant the areas (30 CFR 715.14 (i)).

12. Revegetation. The permittee must establish on all land that has been disturbed a permanent vegetative cover capable of stabilizing the soil surface with respect to erosion (30 CFR 715.20 (a)(2), 717.20 (b), 211.40 (a)(13), and 43 CFR 3041.2-2 (f)(13)).

Any disturbed areas, except water areas and road surfaces approved as part of the postmining land use, which have been graded must be seeded with a temporary cover of small grains, grasses, or legumes to control erosion until an adequate permanent cover is established (30 CFR 715.20 (c)).

Mulch must be used on all regraded and topsoiled areas to control erosion. Annual grains such as oats, rye, and wheat may be used instead of mulch when it can be shown to the regulatory authority that the substituted grains will provide adequate stability until a permanent vegetative cover is established (30 CFR 715.20 (d)).

Areas to be developed for industrial or residential use less than 2 years after regrading has been completed must have a ground cover of living plants that is not less than that required to control erosion (30 CFR 715.20 (f)(2)(ii)).

The following rules and regulations would partially mitigate impacts on air quality resulting from surface and underground mining in northwestern Colorado. These regulations are listed in Table 3-3.

Mitigating effects of specific rules and regulations are summarized in the following sections.

Rules and Regulations

Air Quality Standards

The proposed mines must not cause the National Ambient Air Quality Standards (Federal Register, Vol. 36, November 23, 1971), Colorado Ambient Air Quality Standards (Colorado Air Pollution Control Act of 1970) or the Regulations for Prevention of Significant Deterioration (PSD) (Federal Register, Vol. 43, June 19, 1978) to be violated.

Federal and State Regulations

The 1970 Clean Air Act Amendments established primary and secondary national ambient air quality standards (NAAQS) for six pollutants: total suspended particulates (TSP), sulfur dioxide, nitrogen dioxide, carbon monoxide, photochemical oxidants (ozone), and hydrocarbons. These standards are shown in Table 3-4. The primary standards were set to protect the public health, while the secondary standards were set to protect the public welfare (U.S. Congress 1970).

Colorado has adopted TSP and sulfur dioxide regulations more stringent than the national standards. The Colorado 3-hour standard of 700 ug/m^3 is much lower than the 3-hour national secondary standard of 1,300 ug/m^3. Colorado's present TSP standards require all areas of the state to meet a 45 ug/m^3 annual standard and a 150 ug/m^3 24-hour standard by 1980.

As required by the Clean Air Amendments of 1977, Colorado classified all areas as to their attainment status using existing air quality monitoring data. In the study area, the area within the city limits of Craig has been designated as not meeting primary federal TSP standards. Rio Blanco county, part of which falls within the study area, has been designated as not meeting the federal primary standards for oxidants. No other violations of federal standards for TSP, SO_2, oxidants, CO, or NO_2 are reported (Federal Register, May 3, 1978).

The Federal Regulations for Prevention of Significant Deterioration (Federal Register, June 16, 1978) apply to all areas attaining the National Ambient Air Quality Standards (NAAQS). The 1977 Amendments to the Clean Air Act established "maximum allowable increases" which limit future increases of TSP and sulfur dioxide above baseline concentrations. Ambient concentra-

TABLE 3-3

SUMMARY OF IMPORTANT AIR QUALITY RULES AND REGULATIONS

Rules and Regulations	Authority	Applicability
Colorado Regulation No.1, Section IID	Colorado Air Pollution Control Act of 1970, Chapter 64, Colorado Session Laws 1970. Amended August 1, 1974.	Federal, state and fee coal
40 CFR 52 (Federal Register, Vol. 43, No. 118, June 19, 1978)	1977 Clean Air Act Amendments to Prevent Significant Deterioration.	Federal, state and fee coal
30 CFR 700 (Federal Register, Vol. 42, No. 239, December 13, 1977)	Surface Mining Control and Reclamation Act, Public Law 95-87.	Federal, state, and fee coal
30 CFR 211 (Federal Register, Vol. 41, May 17, 1976)	Federal Coal Mine Health and Safety Act of 1969 (83 Stat 742; 30 USC 801).	Federal
40 CFR 50 (Federal Register, Vol. 36, November 23, 1971)	Clean Air Act of 1970 (Public Law 91-604, 84 Stat. 1679).	Federal, state and fee coal
Ambient Air Standards for Metropolitan Denver Air Quality Control Region, State Air Pollution Control Areas and the State of Colorado	Colorado Air Pollution Control Act of 1970, Chapter 64, Colorado Session Laws, 1970	Federal, state and fee coal

TABLE 3-4

FEDERAL AND COLORADO AMBIENT AIR QUALITY STANDARDS
APPLICABLE TO THE STUDY AREA

Pollutant	Averaging period 1/	Federal primary standards		Federal secondary standards		Colorado state standards
		ug/m^3	ppm	ug/m^3	ppm	ug/m^3
Sulfur dioxide	Annual mean (arithmetic)	80	.03			
	24-hour	365	.14			
	3-hour			1,300	.5	700
Total suspended particulates	Annual (geometric)	75		60		45 2/
	24-hour	260		150		150 2/
Carbon monoxide	8-hour	10,000	9	10,000	9	
	1-hour	40,000	35	40,000	35	
Photochemical oxidants	1-hour	160	.08	160	.08	
Non-methane hydrocarbons 3/	3-hour (6-9 a.m.)	160	.24	160	.24	
Nitrogen dioxide	Annual mean (arithmetic)	100	.05	100	.05	

1/ Standards for periods other than annual are not to be exceeded more than once per year.
2/ Effective in 1970 for non-designated areas and in 1980 state-wide. Effective in 1976 until 1980, the TSP standards for designated areas are 55 ug/m^3, annual and 180 ug/m^3, 24-hour. Grand Junction is the only designated area in the region. The annual state standards are arthmetic means.
3/ Set as a guide to achieve the oxidants standard.

Sources: U.S. Congress, 1970; Colorado Air Pollution Control Commission, 1977a, b.

tions as of August 7, 1977 are considered the baseline concentrations. The "maximum allowable increases" (or increments) were established for three class areas as a function of the desired rise in ambient TSP or SO_2 concentrations. These increments are presented in Table 3-5. The baseline concentration added to the increment cannot exceed the applicable national ambient air quality standard.

Under the PSD regulations the proposed coal-related actions would be subject to a two-tiered analysis to determine the impact of TSP emissions on air quality. First, the proposed actions would be required to employ best available control technology (BACT) and best management practices for the mitigation of TSP emissions. Under the recently promulgated PSD regulations, certain fugitive dust emissions controlled at the BACT level would be excluded from the more detailed second tier analysis. These exempt sources would be those generated by handling and transport of soils uncontaminated by industrial activity. Such sources would include topsoil and overburden removal, transport, dumping, loading and storage. In addition, dust generated by haul road traffic would be exempt from the second tier air quality impact analysis. Fugitive dust generated by mining, handling, and transportation of coal would, however, be included in the analysis.

The maximum allowable increases (or increments) limit the amount of air pollutant-emitting development in an area. The federal Class I area increments allow very little increase in ambient TSP and sulfur dioxide levels. Very little energy-related development is possible for Class I areas. Class II area increments were designed to allow a moderate increase in ambient TSP and sulfur dioxide levels. Class III area increments were designed to allow the maximum increases in ambient TSP and sulfur dioxide concentrations. The highest level of energy-related development is possible for Class III areas. Regulatory measures to prevent significant air-quality deterioration for the other criteria pollutants are to be promulgated by the U.S. Environmental Protection Agency in 1979.

Colorado also has established maximum allowable increases for ambient sulfur dioxide concentrations for prevention of significant air quality deterioration. The Colorado SO_2 increments were developed for three categories. The three Colorado categories have at least one increment that is lower than the increments of the corresponding federal PSD classes, as seen in Table 3-5.

Under the 1977 federal Clean Air Act Amendments, all areas of the country were designated as Class II except for "mandatory" Class I areas. In mandatory Class I areas, visibility cannot be impaired. There are two mandatory Class I areas in the study area. These include the northern tip of the Flat Tops Wilderness Area and the western part of the Mount Zirkel Wilderness Area. The Dinosaur National Monument is a Colorado Category I area. The eastern part of the monument falls within the study area. These areas are shown in Map 2-5. The Colorado Category II and federal Class II areas can be reclassified by the state; however, mandatory Class I and Colorado Category I areas cannot be reclassified.

TABLE 3-5

FEDERAL AND COLORADO MAXIMUM ALLOWABLE INCREASES (INCREMENTS)
FOR THE PREVENTION OF SIGNIFICANT DETERIORATION OF AIR QUALITY

Pollutant	Averaging time	Maximum allowable air quality increases (ug/m3) Category I	Category II	Category III
Colorado 1/				
Sulfur dioxide (SO_2)	Annual mean	2	10	15
	24-hour 3/	5	50	100
	3-hour 3/	25	300	700
Federal 2/		Class I	Class II	Class III
Sulfur dioxide (SO_2)	Annual mean	2	20	40
	24-hour 3/	8	91	182
	3-hour 3/	25	512	700
Total suspended particulates (TSP)	Annual mean	5	19	37
	24-hour 3/	10	37	75

1/ All areas of the state were designated Category II except Colorado Category I areas. See Map 2-5.
2/ All areas of the nation were designated Class II except Mandatory Class I areas. See Map 2-5.
3/ The increments for these averaging times are not to be exceeded more than once per year.

Operating and Emission Regulations

The proposed actions would be required to obtain permits from the Environmental Protection Agency (EPA) based on PSD regulations (Federal Register, Vol. 43, No. 118, June 19,1978). Under the PSD regulations, the proposed mining operations would be subject to a two-tiered analysis to determine the impact of TSP emissions on air quality. First, the proposed actions would be required to employ best available control technology (BACT) and best management practices for the mitigation of TSP emissions. Under the recently promulgated PSD regulations, fugitive dust emissions controlled at the BACT level would be excluded from the more detailed second-tier analysis. Applicants for each of the proposed actions would be subject to the second-tiered air quality impact analysis (including increments, air quality standards, soils, vegetation, visibility, and monitoring) only if non-fugitive dust particlate emissions exceed 50 tons per year.

Although the EPA does not identify specific BACT and best management practices to mitigate fugitive dust from coal mines, a list of possible practices and controls is given in Table 3-6. When obtaining a PSD permit from EPA, the applicant must select practices and controls which are most suitable for the mining operation and which are also acceptable to EPA.

Applicants for the proposed actions would also be required to obtain permits to operate from the Colorado Air Pollution Control Division (Colorado Regulation No. 1, Section IID). Under the regulations the applicant must describe fugitive dust abatement and preventative measures to be used. The Colorado regulations provide a list of acceptable fugitive dust abatement and preventative measures. Each measure on this list is included in Table 3-6.

The Surface Mining Control and Reclamation Act (Federal Register, Vol. 42, December 13, 1977) and the Federal Coal Mine Health and Safety Act of 1959 (Federal Register, Vol 41, May 17, 1976) stipulate general measures to be taken to mitigate air impacts of fugitive dust. Both acts specify that soil erosion must be minimized to control air pollution. In addition, the Federal Coal Mine Health and Safety Act specifies that (1) the lessee must insure compliance with air pollution control measures required by the terms and conditions of other applicable leases, permits, licenses, and approved plans, and (2) the lessee must design coal storage piles to minimize fire hazards and, therefore, air pollution resulting from fires.

TABLE 3-6

POSSIBLE CONTROLS AND MANAGEMENT PRACTICES FOR MITIGATING FUGITIVE DUST FROM COAL MINES

Activity	Control or practices
Overburden removal	Minimize distance of fall from bucket
Blasting/drilling	Minimize blast area
	Use sequential blasting
	Drill with fluid media
	Vent drill into collection device
Truck loading	Minimize fall distance
Truck hauling	Apply paving, water, chemical sealant or some other form of dust suppression to road surface
	Wash, wet down, treat, or cover haul trucks
	Restrict vehicle speeds and haul distances
	Restrict vehicles to designated roads
	Maintain roads and remove loose debris
	Construct "curb-type" structures on roads
Truck dumping	Maintain negative pressure on bottom dump trucks
	Minimize fall distance
	Dump on downwind site of open storage
Storage piles	Employ closed or covered storage
Overburden disposal and exposed areas	Minimize soil pile area
	Cover exposed areas with mulch during re-vegetation
	Furrow spoil piles
	Establish windbreaks
	Minimize topsoil disturbance
	Employ rapid revegetation
Crushing, screening, conveying, and transfer points	Cover or enclose activities
	Install fabric filters
	Water spray activities

The Office of Surface Mining (OSM) interim regulations, 30 CFR 700, will provide certain mitigation of soils impacts associated with mining activities. The specific elements of 30 CFR 715.16, General Performance Standards, will be discussed regarding impacts mitigated during topsoil handling throughout the mining operations including: (a) topsoil removal, (b) topsoil redistribution, (c) topsoil storage, and (d) nutrient and soil amendments. Title 30 CFR 716.7, Prime Farmland, will also be discussed as a special requirement of 30 CFR 715.16, Topsoil Handling.

To optimize reclamation success and meet the requirements of 30 CFR 715.13, 715.16, and 716.7, the permittee will have to conduct a soil survey of the affected area (refer to 30 CFR 211.10), showing distribution of soil type, depth, thickness of horizons, and address suitability of topsoil.

All other regulations of the Colorado Mined Land Reclamation Board and 43 CFR 3041 and 30 CFR 211 relative to mitigation of soils impacts are inclusively covered by the OSM regulations, so for purposes of the following discussion those state and federal regulations will not be repeated.

Rules and Regulations

Topsoil Removal

1. Removal before mining. The topsoil removal section 30 CFR 715.16 (a) and subparagraph (1), supported by 30 CFR 717.20 (a) mitigates loss of topsoil from being utilized or contaminated by requiring all topsoil (unless use of alternate materials is approved under 30 CFR 715.15 (a)(4)) to be removed as a separate operation before any drilling, blasting, mining, road and support facility construction, or other surface disturbing activities. Also in 30 CFR 715.16 (a) (1) provisions are made to reduce soil erosion by limiting size of disturbance at any one time on overburden highly susceptible to erosion.

2. Horizon segregation. Loss of soil productivity will be mitigated by 30 CFR 715.16 (a) (1) and (2), requiring horizon segregation (soil horizons identified by soil surveys) and maximizing use of horizons to achieve 100 percent soil productivity consistent with post-mining land use (30 CFR 715.13). Title 30 CFR 715.15 (a) (4) mitigates loss of any overburden material suitable as a plant growth medium or mixing of this with unsuitable material, by separating and storing soil by soil horizon. This activity will be backed up by chemical and physical analysis and/or field trials and greenhouse studies (all certified by a qualified soil scientist or agronomist).

Topsoil Redistribution

1. Mitigating loss of productivity and soil. During topsoil redistribution, 30 CFR 715.16 (b) will mitigate loss of soil productivity by requiring immediate replacement of topsoil, scarification of regraded surface prior to topsoiling eliminating slippage surfaces and promoting root penetration, topsoiling in a uniform thickness, prevention of excessive compaction on spoil or topsoil, and protection of topsoil from wind and water erosion before seeding and planting. Soil loss also can be mitigated by eliminating slippage surfaces and protecting redistributed topsoil from wind and water erosion.

2. Addition of nutrients and soil amendments. Title 30 CFR 715.16 (d) provides for addition of nutrients and soil amendments, as prescribed by soil tests, to be applied to redistributed topsoil. Title 30 CFR 715.16 (d) will mitigate loss of soil productivity by meeting post-mining requirements of 715.13 and reducing soil loss by supplementing nutrient deficient topsoil to establish vegetation required by 30 CFR 715.20.

Topsoil Stockpiling

1. Stabilization of stockpiled soils. Title 30 CFR 715.16 (c) deals with topsoil stockpiling if allowed by the permit and will aid in mitigating soil loss by stockpile placement in a stable area not to be disturbed until redistribution, protected from wind and water erosion, and planted with a protective vegetative cover as defined in 30 CFR 715.20 (g).

2. Mitigating loss of productivity. Loss of soil productivity will be mitigated by 30 CFR 715.16 (c), reducing unnecessary compaction, segregation horizons, and avoiding contamination which will lessen soil capability to support vegetation.

Determination and Treatment of Prime Farmland

To comply with 30 CFR 716.7, Prime Farmland, each applicant for a mining permit will have to determine the status of farmlands to be mined, according to 30 CFR 716.7 (b) and (c), Definition and Identification of prime farmlands; and 30 CFR 716.7 (d), Negative Determination of prime farmland. If a positive determination is made, a restoration plan will be submitted in compliance with 30 CFR 716.7 (e),(f), and (g). Mitigating loss of the high soil productivity associated with lands used for production of cultivated crops will be accomplished by 30 CFR 715 and special requirements 30 CFR 716.7 (g). The soil survey will act as the base for compliance with the special requirements, defining depth and thickness of each horizon for the original undisturbed soil profiles. Specific elements mitigating loss of soil productivity will include: horizon segregation defined in 30 CFR 716.7 (g)(1), separation of horizons if stockpiling is required

(30 CFR 716.7 (g)(3)), and reconstruction of a soil having an equal or greater productivity than existed prior to mining (30 CFR 716.7 (g)(4) and (5)). Special attention in soil reconstruction is given to replacing the B horizon or other suitable material specified in 30 CFR 716.7 (g)(1)(ii) and (g)(1)(iii) to a comparable thickness of root zone that existed prior to mining and to replacing a thickness of A horizon comparable to the original soil, having equal or greater productivity capacity.

Revegetation

Revegetation on all areas of future coal development will follow the federal surface mining reclamation and enforcement provisions and rules and regulations for the State of Colorado. Both state and federal rules and regulations can be found in Appendix A, Section 1.

The Office of Surface Mining (OSM) regulations in 30 CFR 700 differ from previous federal regulations in that they are more specific in certain areas to help mitigate the impacts on vegetation due to surface mining.

Rules and Regulations

1. Species used in revegetation. Title 30 CFR 715.20 (a) requires the permittee to revegetate the disturbed areas with species native to the area, and that revegetation be carried out in a manner that encourages prompt vegetative cover.

Title 30 CFR 715.20 (b) states that introduced species may be used. This is also similar to the 30 CFR 211 codes for revegetation (refer to NWCCRES, Chapter IV, Mitigating Measures), but 715.20 (b) requires that if introduced species are used, appropriate field trials must have demonstrated that the species are equal or superior to premining species for the approved post-mining land use.

Title 30 CFR 715.20 (e) states that the permittee shall use publications or laboratory results for varieties, species, seeding rates and soil amendment practices. This is to reestablish soil stability and prevent erosion.

Title 30 CFR 715.20 (e)(2)(3) state that hayland, pasture, range, and forest areas shall be revegetated to obtain a diverse, effective, and permanent vegetative cover with the seasonal variety, succession distribution, and regenerative capabilities of vegetation native to the area, and livestock grazing will not be allowed on reclaimed land until seedlings are established and can sustain managed grazing. With these mitigations, loss of diverse vegetation, loss of natural seed source, and loss of production should be curtailed after mining activity.

2. Time of revegetation. Title 30 CFR 715.20 (c) not only covers the mine site itself, but also haul roads and all areas that will require regrading to reduce soil erosion. Seeding and planting of disturbed areas shall be conducted during the first normal period of favorable planting conditions after final preparations.

3. Measures to enhance regrowth. Title 30 CFR 715.20 (d) requires that mulch shall be used on all regraded and topsoiled areas to control erosion, to promote germination of seeds, and to increase the moisture retention of the soil. Title 30 CFR 211.40 (a)(14)(ii) provides for the fencing of active mining operations and land undergoing reclamation to enhance regrowth by preventing livestock grazing until vegetation has become adequately established.

4. Measuring success of revegetation. Title 30 CFR 715.20 (f)(1) states that standards for measuring success of revegetation will be established by setting up control areas that are representative of geology, soils, slope, aspect, and vegetation in areas where there is mining. These control areas will not be disturbed. They will serve as comparisons against which the success of revegetation in reclaimed areas is measured.

Title 30 CFR 715.20 (f)(2) states that the ground cover on the revegetated areas shall be equal to that of the control areas - not less than 90 percent of the ground cover in control areas. But in previously mined areas, the ground cover shall not be less than the amount sufficient to control erosion, and in no case less than that existing before redisturbance (30 CFR 715.20 (f)(2)(i)). For areas to be returned for agricultural cropland purposes, success of revegetation shall be determined on the basis of crop production from the mined area compared to the control area (30 CFR 715.20 (f)(2)(iii)).

Title 30 CFR 715.20 (f)(3) states that evaluation of species diversity, distribution, seasonal variety and vigor shall be made with regulatory authority. With this requirement, loss of species diversity and successional stages can be decreased. Title 30 CFR 715.20 should mitigate the impacts of surface mining after mining activity has ceased in northwest Colorado.

5. Revegetation during stockpiling. Title 30 CFR 715.20 (g) states that the topsoil removed shall be stored and seeded with annual or perennial non-noxious plants, which will reduce the topsoil lost in stockpile due to erosion.

Title 30 CFR 717.20 (a) requires that the permittee segregate, stockpile, and protect from wind, water erosion, or contaminants the topsoil in areas to be strip mined. After mining, distrubed areas shall be regraded, topsoil distributed, and revegetated. Title 30 CFR 717.20 (b) requires that the permittee establish on these lands a diverse, effective, self-regenerative, and permanent vegetative cover capable of plant succession and adequate to control soil erosion. Introduced species may be substituted for native species if approved by regulatory authority.

Wildlife

Regulations governing surface and underground coal development operations would mitigate some of the impacts on wildlife species in the region.

The Office of Surface Mining (OSM) Reclamation and Enforcement Provisions, 30 CFR 700, contain several general statements dealing with the protection of wildlife species and habitat. Interpretations of these general regulations would have to be made in order to apply them to specific wildlife populations and habitat situations.

Federal Rules and Regulations

1. Postmining restoration of wildlife habitat. Title 30 CFR 715.13 (c)(10) of the OSM regulations requires that wildlife habitat that has been disturbed by mining activity be restored unless certain criteria concerning an alternative post-mining use of the area are met. This would minimize the permanent loss of much wildlife habitat although certain critical wildlife areas such as elk calving grounds or sage grouse strutting grounds could not be restored, due to their unique vegetation patterns and microclimates.

2. Protection of riparian habitat. Title 30 CFR 715.17 (d)(1)(iii) requires the protection of riparian habitat along stream channel diversions and intermittent and perennial streams through consultation with appropriate federal and state fish and wildlife management agencies. Riparian zones are critical to a large number of wildlife species due to the presence of water, the higher amount of biomass production, and the greater diversity of vegetation.

Title 30 CFR 715.17 (d)(3) requires that surface mining and reclamation not be carried on within 100 feet of an intermittent or perennial stream unless the regulatory authority specifically authorizes it through such a stream.

3. Maintenance of habitat during mining. Title 30 CFR 715.20 (e)(4) requires that during revegetation the needs of wildlife be taken into account. It also requires that appropriate plant species be selected and grouped and that water resources be spaced to fulfill the habitat requirements of wildlife. This is to ensure that reclaimed areas designated as wildlife habitat would fulfill the requirements of wildlife and thus would be utilized.

The Federal Coal Lease (Form 3130-1 October 1, 1967) Section 5, requires the lessee to refrain from unnecessarily causing soil erosion or damaging forage and timber growth on leased lands, to mitigate impacts of mining activity on wildlife and domestic faunal habitat and food sources.

The Migratory Bird Treaty Act (40 Stat. 755, as amended, 49 Stat. 1555) provides definitive regulations and guidelines to protect the eagle and other raptors from the adverse effects of habitat losses near their nests.

4. Mitigating hazards to wildlife. Title 30 CFR 211.40 (a)(14)(ii) requires that areas where mining or reclamation is being carried on be fenced to prevent grazing by livestock until vegetation has become adequately reestablished. These fences are hazards to wildlife. To minimize hazards, fence construction in big game range will be required to follow the guidelines presented in BLM Manual 1737. Such construction will also minimize impacts on movement of wildlife.

5. Threatened and endangered species. According to the Endangered Species Act of 1973, the designated regulatory authority must determine if any endangered species of wildlife exist in mining areas. Any action that would alter existing habitat of such species would require in-depth research to insure that they would not be harrassed in any way.

Section 7 of the Endangered Species Action of 1973 (Federal Register 43 (2): 870-876, January 4, 1978) outlines the procedural aspects of necessary formal and informal consultation with the Fish and Wildlife Service on impacts to threatened and endangered species resulting from proposed actions of other agencies.

BLM Instruction Memorandum No. 78-162 details procedures for formal and informal consultation concerning endangered species for the environmental assessment process. These new regulations prohibit adverse impacts to threatened and endangered species which would result from coal leasing. Because there is no proposed action in this report, only informal consultation with the Fish and Wildlife Service (FWS) has been carried out. Should specific areas be indicated for possible future leasing, formal consultation with FWS would be required.

Under the Bald Eagle Protection Act of 1969 (16 USC 668-668c), mining operations will not be permitted in any area where such activities would molest or disturb bald and (or) golden eagles and (or) their nests.

Under the Fish and Wildlife Coordination Act of 1958 (18 USC 661, et seq.), consultation and coordination with the U.S. Fish and Wildlife Service is required where a proposed or carried out action involves navigable waters and may affect the fish and wildlife resource. The legal definition of navigable waters is any body of water that will successfully float a 6-inch in diameter and 6-foot in length balsa wood log.

State Rules and Regulations

Rules and regulations of the Colorado Mined Land Reclamation Board are more specific with regard to the protection of wildlife species and habitat than the OSM provisions.

1. Contents of application for mining permit. Rule 2, 2.12 (8) specifies the wildlife information to be presented in applications for a regular mining operation permit. This requires an inventory of the significant wildlife resources on the affected land. It also requires a full description of the expected effects of a mining operation on the wildlife in the area. Applicants for permits for limited impact operations and special operations are also required to present an inventory of the wildlife resources on the affected land.

2. Protection of wildlife during mining. Rule 6, 6.3 requires that the mining and reclamation plan take into account the safety and protection of the wildlife on the mine site, the processing sites, and along all access roads. It also states that if wildlife habitat management and creation are a part of the reclamation plans, the plan be directed toward encouraging the diversity of wildlife species in the area. This would help protect individual animals during the mining operation and would minimize the permanent loss of habitat.

Domestic Fauna

Rules and Regulations

The Office of Surface Mining (OSM) Reclamation and Enforcement Provisions, 30 CFR 700, contain provisions that bear on the protection and maintenance of livestock.

Title 30 CFR 715.20 (e)(2) requires that where hayland, pasture, or range is to be the postmining land use, the area shall be revegetated to provide a diverse, effective, and permanent cover with the seasonal variety, succession, distribution, and regenerative capabilities native to the area. Until the new vegetation is sufficiently established, grazing will not be allowed on the land. When vegetation is established will be determined by the regulatory or land management agency having jurisdiction.

Title 30 CFR 715.20 (e)(3) contains similar provisions for areas in which forest is to be the principal postmining land use.

Title 30 CFR 715.13 (a) provides that all disturbed areas shall be restored in a timely manner to conditions that are capable of supporting the uses that were carried on before mining or achieving higher or better uses. Under 30 CFR 715.13 (d), these criteria and procedures are determined by the regulatory authority in consultation with the landowner or the land-management agency having jurisdiction over state or federal lands.

The Federal Coal Lease (Form 3130-1) October, 1967) Section 5, requires the lessee to refrain from unnecessarily causing soil erosion or damaging forage and timber growth on leased lands, in order to mitigate impacts of mining activity on domestic faunal habitat and food sources.

Aquatic Biology

Impacts resulting from activities associated with both surface and underground mines should be mitigated with enforcement of the following three regulations:

1. Department of the Interior Office of Surface Mining (OSM) Reclamation and Enforcement, 30 CFR 700.

2. The Colorado Mined Land Reclamation Board Rules and Regulations.

3. The Endangered Species Act of 1973.

The OSM regulations (30 CFR 700) contain requirements that will preserve and protect the aquatic resources.

Federal Rules and Regulations

1. Protection of aquatic habitat through land use provisions. One of the major impacts from mining is loss of habitat due to alteration of land usage in post-mining. Title 30 CFR 715.13 (c)(9) and (10) give categories of land use, and 30 CFR 715 (d)(8) and (9) stipulate criteria that have to be met to change land use. These provisions should alleviate any major loss of aquatic habitat.

Under the Fish and Wildlife Coordination Act of 1958 (18 USC 661, et seq.), consultation and coordination with the U.S. Fish and Wildlife Service is required where a proposed or carried out action involves navigable waters and may affect the fish and wildlife resource. The legal definition of navigable waters is any body of water that will successfully float a 6-inch in diameter and 6-foot in length balsa wood log.

2. Storage and disposal of waste and spoil material. Title 30 CFR 715.15 gives requirements for disposal of spoil and waste material in areas other than the mine workings or excavations. This would help protect water quality from any drastic changes and maintain the integrity of the aquatic community. Title 30 CFR 715.17 (k) would enable permanent impoundments to be constructed on the mine site. Title 30 CFR 715.18 should prevent waste material being stored and then leaching or leaking into the streams, which would impact the aquatic biology of the region.

3. Water quality standards. Title 30 CFR 715.17 deals with water quality standards and effluent limitations. This is the most important section in preserving the aquatic ecosystem from impacts due to mining and is covered in much more detail in the Water Resources section of this chapter. The most important are: 30 CFR 715.17 (a),(b),(c),(c)(iii), (d)(2), (d)(3) and (e).

4. Reduction of siltation. The single most important threat to aquatic life of the region is any increase in siltation due to mining. Siltation is covered by the following regulations, already discussed in the Water Resources section of this chapter: 30 CFR 715.16, 715.17, 715.18, 716., 716.3,

716.4 (c)(3), 717.15, 717.17, 717.18, and 717.20. All of the above regulations will eliminate or reduce impacts to aquatic communities from siltation that mining creates.

State Rules and Regulations

The rules and regulations of the Colorado Mined Land Reclamation Board, which are governed by the Colorado Mined Land Reclamation Act of 1976, mitigate many of the same impacts mitigated by OSM. Since the OSM regulations are more stringent, they supersede the Colorado rules. It should be noted, though, that all these rules have to be followed and are enforced on all lands mined in Colorado.

Endangered Species Act of 1973

According to the Endangered Species Act of 1973, the designated regulatory authority must determine if any endangered species of wildlife exist in mining areas. Any action that would alter existing habitat of such species would require in-depth research to insure that they would not be harrassed in any way.

Section 7 of the Endangered Species Action of 1973 (Federal Register 43 (2): 870-876, January 4, 1978) outlines the procedural aspects of necessary formal and informal consultation with the Fish and Wildlife Service on impacts to threatened and endangered species resulting from proposed actions of other agencies.

BLM Instruction Memorandum No. 78-162 details procedures for formal and informal consultation concerning endangered species for the environmental assessment process. These new regulations prohibit adverse impacts to threatened and endangered species which would result from coal leasing. Because there is no proposed action in this report, only informal consultation with the Fish and Wildlife Service (FWS) has occurred. Should specific areas be indicated for possible leasing, formal consultation with FWS would be required.

Archeological Resources

Essentially, all legislation has been intended to preserve and, where possible, to enhance archeological resources. Throughout the legislative history of historic preservation, specific objectives and methods to reach those objectives have evolved. To comply with the legislation, five processes must be taken into consideration and, if applicable, completed. The five processes are (1) inventory of archeological resources within the control of the Bureau of Land Management; (2) evaluation of all resources against the four criteria of significance prescribed for nomination to the National Register of Historic Places (NRHP); (3) the nomination of resources to NRHP; (4) determination of effect resulting from a proposed federal action to resources on or eligible to NRHP; and (5) preservation of resources not eligible to NRHP. The applicable legislation is discussed in relation to these five processes.

Rules and Regulations

The Antiquities Act of 1906 (34 Stat. 225, 16 USC 431 et seq.) is the first law to establish the preservation process for archeological resources on public land. The Secretary of the Interior is charged with carrying out the provisions of the Act for lands under the jurisdiction of BLM. It establishes criminal sanctions against illicit destruction or removal of resources and establishes a permit system requiring licensed institutions to preserve collected data by publication and by storage of physical data.

The Colorado Antiquities Act of 1973, similar in provisions and intent to the federal antiquities act, establishes the preservation process for archeological resources on state-owned land. The State Historical Society is charged with carrying out the provisions of the Act. It issues permits to qualified applicants for field work. Anyone who destroys or removes archeological resources from state land without a society permit is subject to criminal sanctions. It is assumed that this Act includes all five processes.

The National Historic Preservation Act of 1966 (80 Stat. 915, 16 U.S.C. 470 et seq.) authorizes the Secretary of the Interior to expand the National Register to include resources having state and local significance and to establish the Advisory Council on Historic Preservation, which among other duties, reviews and comments on documentation of the harmful effects resulting from any proposed federal action on resources on NRHP or eligible for inclusion on NRHP. Agencies are directed under Section 106 of the Act to produce documentation of the degree of effect according to specific procedure and in consultation with the State Historic Preservation Officer. If NRHP quality resources will be harmfully effected, alternatives of avoidance of these resources or mitigation of the effects must be offered. The Act

requires inventory, evaluation of significance, and the determination of effect on resources on or eligible to NRHP and preservation by avoidance or mitigation.

Executive Order (E.O.) 11593 (1971) directs federal agencies to inventory resources under their jurisdiction and to nominate resources eligible to NRHP. During this time, the agencies are to exercise caution in activities they either initiate or license to allow for the processes of inventory and evaluation of eligibility and where necessary to allow the Advisory Council to comment on the efforts harmful to the resources from such activities. This order stresses inventory, evaluation of significance, nomination, and determination of effect on resources eligible to or on NRHP. It assumes that inventory, evaluation of significance, and nomination would be completed by mid-1973.

The three processes, inventory, evaluation of significance, and, where necessary, determination of effect, are often telescoped into a short period of time. Since the Advisory Council may require a review period as long as 180 days in complex cases of harmful effects to resources on or eligible to NRHP, BLM or lessees should begin the inventory process as early as possible in planning or proposing any activity.

Publicly owned minerals may underlay private or state-owned surfaces. In such cases, the opinion of the Assistant Solicitor for Parks and Recreation, U.S. Department of the Interior issued on September 10, 1974 (NWCCRES, Regional Analysis IV-10), applies to assure fulfillment of requirements of 80 Stat. 915 and E.O. 11593 Section 1 (3) by completion of the inventory and the nomination processes.

BLM is directed by E.O. 11593 to work with the State Historic Preservation Officer (SHPO) in developing a program to identify resources and evaluate their significance both on public and private lands, to assure that resources of national, state and local significance are preserved. This directive seems to dovetail with the objectives of Colorado House Bill 1041 regarding archeological resources. House Bill 1041 includes, within the Colorado land use program, the objectives of having local governments identify archeological resources which are eligible to NRHP or to the Colorado Register of Historic Places. The inventory process specified here, however, does not seem to stress on-the-ground survey. Once specific resources are identified they become areas of state interest and appropriate state agencies are directed to assist local governments in administering them. If development occurs in or near areas of state interest containing archeological resources, avoidance of the resource or mitigation of effect is inferred. Again Colorado presses for all five processes. Under House Bill 1041 both state and private lands are included.

Title 43 CFR 2801.1-5 (a) and 2801.1-5 (h) have been discussed previously (NWCCRES, Regional Analysis, IV-9). To be granted and to retain a right-of-way permit, the applicant must comply with applicable federal and state laws. With regard to archeological resources, the applicant may have to assume the responsibility of completing all five

processes.

The fifth process, preservation of resources not eligible to NRHP, is required for resources on federal and state lands according to their respective antiquities acts. Although resources may not meet the criteria of significance for nomination to NRHP, they may contain data useful in defining the spatial distributions of specific prehistoric groups or of identifiable cultural horizons. Under 43 CFR 3041.2-2 (d) and, similarly, under the Colorado Land Use Act of 1974 (House 1041), the lessee is required to conduct intensive surveys under conditions specified and monitored by the designated regulatory authority and to preserve or minimize damage to those resources in accordance with the terms and conditions of the lease.

Historic Resources

Rules and Regulations

Federal legislation provides for strict controls regarding the preservation of historic sites and locations. The legal methods of preservation include the 1935 Historic Sites Act (16 USC 461-467), the Historic Preservation Act of 1966 (16 USC 470), Executive Order 11593 (1971), and the Federal Land Management and Policy Act of 1976.

Since most sites that may be affected by proposed surface or subsurface mining actions can be mitigated through inventory recordation, salvage, and/or relocation, those sites that would be directly impacted through mining activity would be mitigated pursuant to the Historic Preservation Act of 1966 (36 CFR 800). Under these regulations, the State Historic Preservation Officer (SHPO) will be consulted in the evaluation and mitigation of historic sites likely to be affected by federal actions on federal lands and/or where there is federal mineral estate involved. Those sites on private lands may be recorded where possible and the SHPO will be provided available data for these sites. The SHPO is responsible for nominating to the National Register of Historic Places those sites on private lands.

Coal leasing on federal lands will occur in accordance with to 36 CFR 800 procedures and the SHPO and the Advisory Council on Historic Preservation (ACHP) must be given the opportunity to comment on the decision to develop coal resources prior to that action. Mitigation plans will be developed at that time in concert with these two agencies.

Aesthetics

The NWCCRES discussed in detail the legal provisions existing for the protection of the visual resources. They are summarized below.

Rules and Regulations

1. Planning, location, and construction of facilities. Enforcement of provisions of 43 CFR 3041.2-2(d) would ensure that applicants take visual resources into account in the planning, location, and construction of facilities on the proposed operation. To comply with this regulation, the following measures would be taken:

Cut and fill slopes resulting from all rights-of-way, exploration, building, and other mine-related facility locations would be shaped to a rounding grade that would intersect adjacent terrain at a very low angle; this would help avoid creation of harsh angular forms. All mine spoils and topsoil stockpile areas would also be reshaped to a landform that would borrow from the adjacent topography. Title 43 CFR 3041.2-2(f)(2) and 30 CFR 211.40(a)(2) further require elimination of highwalls and spoil piles and restoration of the approximate original contour. This would require reshaping of spoil piles and replacement of overburden to conform with or borrow from the adjacent contour.

In addition, implementation of 43 CFR 3041.2-2(f)(12)(ii) would reduce visual impacts accruing to road construction; it requires all roads to be located on flatter slopes to minimize disturbance; this is also required by 30 CFR 211.40(a)(12)(ii) and by 30 CFR 715.14 (a)(b).

2. Reestablishment of vegetative cover. Reestablishment of a vegetative cover on all disturbed lands is required by 43 CFR 3041.2-2 (f)(13)(i); this would help mitigate visual impacts on denuded areas; it is also provided for in 30 CFR 211.40(a)(13)(i) and 30 CFR 715.20 (a)(2). Part 1-f, Section 34-32-116, of the Colorado Mined Land Reclamation Act (H.B. 1065) also directs the establishment of a self-sustaining long-term vegetative cover. These revegetation efforts would begin as soon as possible following cessation of surface-disturbing activities.

3. Litter, spoils and pollution. A litter-free landscape would be maintained by screening refuse disposal and storage areas, and by regularly disposing of discarded equipment, waste, and litter. Title 43 CFR 3041.2-2(f)(8) requires the applicant to dispose of rubbish to prevent air pollution. Section 34-32-116, Part 1-e of the Colorado Mined Land Reclamation Act (H.B. 1065) directs refuse disposal in a manner that would control unsightliness.

Also Part 1-i, Sec. 34-32-116, of the Colorado Mined Land Reclamation Act requires that off-site areas be protected from slides or other damage due to mining or reclamation. Implementation of this constraint would prevent the dumping of mine spoils or road fill over steep slopes or escarpments, and the resultant form-dominant visual

intrusions. This constraint is also provided for in 30 CFR 715.15 (a). All material excavated on steep slopes, whether from surface mining itself or attendant right-of-way construction, would therefore need to be hauled away from the steep slopes, and not conveniently dumped on them.

Regulation No. 1, Emission Control Regulations for Particulates, Smokes, and Sulphur Oxides for the State of Colorado, Section II-D, Fugitive Dust, (Colorado, 1971) prohibits mining operations from occurring without a permit that specifies fugitive dust control measures. Implementation of these measures would reduce potential for atmospheric haze. In addition, 43 CFR 3041.2-2(f)(11) and 30 CFR 715.14 require the applicant to construct and maintain all roads and other utility access facilities in a manner that would minimize, control, or prevent fugitive dust. Regular sprinkling with water, or oiling, would be required to control dust on all haul and access roads; such dust control measures are approximately 30 percent efficient.

The Colorado Department of Health's water quality standards (1974) provide regulations consistent with provisions of the Federal Water Pollution Control Act amendments of 1972 and 30 CFR 715.15. Enforcement of this legislation would prevent the proposed mining operation from contributing floating debris, scum, and discoloration to downstream drainages.

4. Impacts of right-of-way construction. Impacts to aesthetics which are caused by right-of-way construction would also be mitigated as outlined above under the provisions of 43 CFR 2801.1-5(a) and 2801.1-5 (h) Rights-of-way; Terms and Conditions. These regulations note that the foregoing federal and state laws are applicable to coal-related projects for which rights-of-way would be approved, and include other regulations necessary to render such rights-of-way approvals compatible with the public interest. These regulations as well as those in 30 CFR 715.14-15 would be required and enforced as conditions upon which right-of-way approval would be granted.

5. Protection of visual or scenic resources in general. The Federal Land Policy and Management Act of 1976 makes specific provisions for the protection of visual or scenic resources.

a. Sec. 103(a) - when public land is affected by development, important scenic values will be protected from irreparable damage.

b. Sec. 103(c) - scenic values will be given equal consideration when weighting the use of non-renewable and renewable natural resources.

c. Sec. 202 (c)(3) - in the development and revision of land use plans, the Secretary of Interior shall give priority to the designation and protection of areas of critical environmental concern (for specific values).

d. Sec. 302(b) - in managing the public lands, the Secretary of the Interior shall, by regulation or otherwise, take any action necessary to prevent unnecessary or undue degradation of the lands, including the scenic values.

e. Sec. 504(a)(4) - Right-of-way boundaries shall be limited to the ground where it has been determined (by BLM) that no unnecessary damage will occur to the environment.

In addition, the Surface Mining Control and Reclamation Act (SMCRA) (30 CFR 700) states that the OSM regulatory program is to protect the environment from adverse effects of surface coal mining and surface impacts of underground coal mining. This includes scenic values. Section 715.13 describes methods of reclamation, the implementation of which would benefit scenic values. Other sections under this title would also benefit aesthetic values as a by-product of their principal thrust. Sections 716.2 and 716.3 list criteria that would help protect the scenic resources when mountaintops are mined and when mining occurs on steep slopes. Sections 717.14 and 717.15 list measures that would protect scenic resources which might be adversely affected as a result of underground mining. Section 717.20 would protect scenic resources affected by the removal, storage, and replacement of topsoil and reclamation of areas no longer needed for mining.

Recreation

Rules and regulations in 30 and 43 CFR state that all mined lands will be reclaimed, that operators of mines will minimize, control, or prevent disturbances that affect the quality of surface water, that impoundments will not affect the quality of downstream water, that mining operations will be done in a way to prevent damage to fish, wildlife, and their habitat, that water impoundments and retention dams will be constructed in a way that provides safety and access for anticipated recreation water users, and that rights-of-way will be constructed to mitigate impacts on recreation resources. For further elaboration, see Recreation, Chapter IV, NWCCRES.

Rules and Regulations

Rules and regulations for 30 CFR 211, 43 CFR 3041, and the Colorado Open Mined Land Reclamation Act (HB 1065) will all be modified by the rules and regulations from the Surface Mining Reclamation and Enforcement Act (Federal P.L. 95-87; August 3, 1977). Requirements in this law and the 30 CFR 700 regulations to protect recreation values follow.

Modifications

1. Destruction of aesthetic values. Section 522 (a)(3)(B) of the Act prohibits certain types of surface coal mining operations if such operations affect fragile or historic lands in which such operations could result in significant damage to important historic, cultural, scientific, and aesthetic values and natural systems. This requirement is very similar to the Areas of Critical Environmental Concern Section 202 (c)(3) in the Federal Land Policy and Management Act but adds one feature: a specific site in a mining area can be designated as unsuitable and mining not allowed.

2. Timely restoration of disturbed lands. Title 30 CFR 715.13 (a) requires that all disturbed areas be restored in a timely manner to conditions capable of supporting premining uses or higher uses, after consultation with the landowner or land-management agency having jurisdiction. Recreation would be one of the higher uses.

3. Protection of aesthetic values during mining. Title 30 CFR 715.17 and 717.17 require that water quality not be degraded nor quantity diminished during construction of rights-of-way, maintenance, and reclamation in mining areas. See the Water Resources, Chapter 3, for elaboration.

Correction to NWCCRES

One correction should be noted in the Recreation Section, Chapter IV, NWCCRES, on page IV-13, column 2, paragraph 2. The first sentence should read, "On lands owned by the operator, the operators may permit the public to use the same for recreational purposes except in areas where he determines such use to be hazardous or objectionable." The original sentence said operators must permit the public to use lands owned by the operator for recreational purposes.

Rules and Regulations

1. Highway Improvement and Maintenence. The State of Colorado receives money under Section 35 of the Mineral Leasing Act. Part of the Section 35 money could be used for public roads in the impacted areas, possibly to construct grade separations at railroad crossings and improve and maintain impacted roads in the area. Car-train accidents, time impacts at railroad crossings, and other auto accidents would be reduced if the proper improvements are made, but the U.S. Department of the Interior cannot guarantee these improvements since the distribution of Section 35 money is determined by the state legislature.

2. Construction and Abandonment of Railroad. The Interstate Commerce Act (49 Stat. 543, 49 USC 1(18)) requires prior approval by the Interstate Commerce Commission for extension or new construction of a line of railroad or for abandonment of a line of railroad. Spur, industrial team, switching, or side tracks located wholly within one state are exempted from this authority.

3. Rights-of-way on public land. Titles I and V of the Federal Land Policy and Management Act (FLPMA) of 1976 provides laws to be followed for rights-of-way across public lands. Rights-of-way included are roads, railroads, transmission lines, pipelines, etc. These laws will govern the location and construction of rights-of-way on public land and provide for mitigation of impacts.

General terms and conditions for rights-of-way are outlined in 43 CFR 2801.1-5. The applicant must comply with state and federal laws applicable to the project and during construction and maintenance of the project to minimize adverse effects, especially regarding fire and erosion, and to restore the area to its original condition as nearly as possible after construction. The applicant must also repair all roads, etc., that are altered or damaged during construction of the project.

Title 43 CFR 2802.2-2 stipulates that construction must be timely, completed within 5 years of the granting of the right-of-way, or be subject to cancellation. No deviation from the location of an approved right-of-way is permissible without approval of the designated authority (43 CFR 2802.2-4).

Specific regulations for rights-of-way for roads and highways are covered in 43 CFR 2820; for railroads, 43 CFR 2840; for power transmission lines, 43 CFR 2850; for telephone lines, 43 CFR 2862; for water facilities (including irrigation and water livestock), 43 CFR 2870; and for mineral leasing purposes, including pipelines, 43 CFR 2880. These regulations indicate methods of application and procedures and authorities applicable to the respective projects.

Additional regulations pursuant to FLPMA are currently in preparation in accordance with the authorities of Titles I and V of the Act.

BLM PLANNING SYSTEM

The Federal Land Policy and Management Act of 1976 (FLPMA) formally legislated the requirement of comprehensive land use planning for public lands. The Federal Coal Lease Amendments Act of 1975 (FCLAA) requires that coal leasing must be compatible with land use planning within public land areas and that coal leases cannot be issued unless compatible with such plans.

BLM's planning process for use of public lands is guided by basic resource inventory, called unit resource analysis (URA), and by management decisions developed in a management framework plan (MFP).

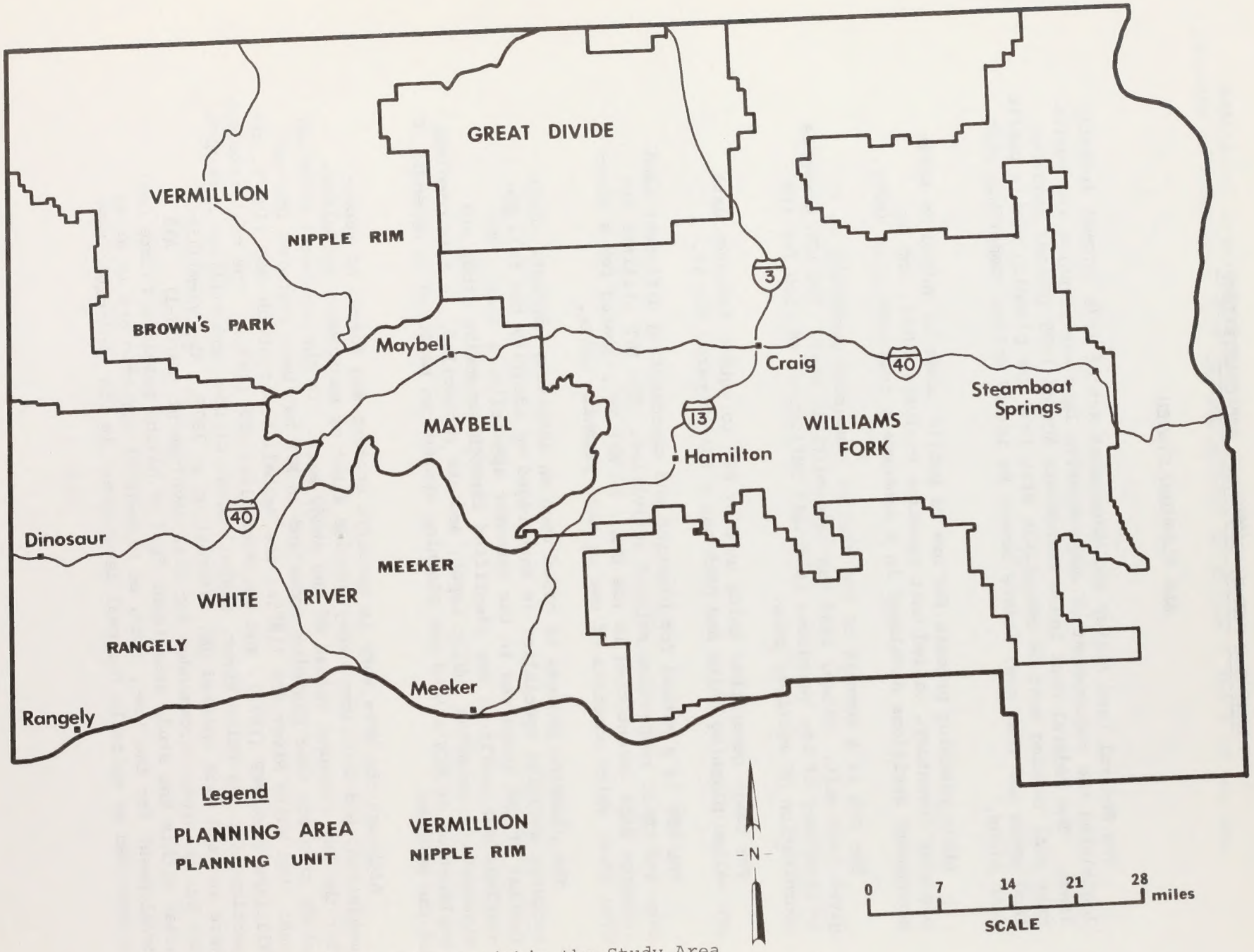
The URA is a summary of the various resources occurring on a given land unit. Often, land can have multiple uses. The URA presents an inventory of its resources in detail sufficient to plan for the coordination of multiple uses.

The basic geographic units used by BLM to gather resource data are called planning units and each has a URA prepared for it.

The MFP is a method for planning and coordinating different land uses and their respective related activities. The MFP utilizes the resource data inventoried in the URA. An MFP is prepared for a planning area, which consists of one or more planning units.

The planning process is based upon an adversary concept. Each resource activity specialist is encouraged to identify the full potential of the resources in the resource specialist's area. The overlaps and conflicts are identified through extensive study and discussion, including public input, and are reconciled. A more complete explanation of BLM's land use planning system can be found in Appendix D of the NWCCRES.

Although the MFPs vary in specific content and format of recommendations and decisions, they provide a set of management guidelines for the key resource values of the study area. In the northwest Colorado study area are four planning areas and an MFP has been prepared for each one: the White River MFP (1975), the Maybell-Great Divide MFP (1977), the Williams Fork MFP (1972), and the Vermillion MFP (1972). The coal resource portions for the White River, Maybell-Great Divide, and Williams Fork MFPs were revised with updated URA information in 1977. The Vermillion MFP has no areas recommended for coal development (Map 3-1). All areas within the study area identified as having possible future coal development for the low-, mid-, or high-level scenario are in areas recommended as suitable for coal development in the applicable MFPs.



Map 3-1. Planning Areas within the Study Area

STATE AND LOCAL LAND USE PLANS

Local county governments have been authorized and instructed by the Colorado general assembly to plan for and regulate the use of land within their respective jurisdictions (see Chapter 106, Colorado Revised Status, as amended). All three counties within the study area - Routt, Moffat, and Rio Blanco - have adopted formal zoning regulations.

Local comprehensive land use planning is in the initial stage in these three counties. Only Rio Blanco County has a completed master plan for county-wide development. All counties have basic land use plans for the major cities within their respective boundaries. Routt County has completed and approved their comprehensive land use plan goals and objectives section.

Recent legislation should provide the resources necessary for the counties to continue planning. In the interim, the counties' controls on development are imposed through use of conditional use and special use permits.

Colorado House Bills 1034 and 1041 give counties and municipalities authority and funding to develop plans for all lands within their boundaries. A principle feature is authority to designate "areas and/or activities of state interest," to protect areas which have specific values for the locale. Inventory and planning efforts are currently under way. Areas that may be designated as "areas of state interest" include the following:

1. Mineral resource areas.

2. Natural hazard areas.

3. Areas containing or having significant impact upon historical, natural, or archeological resources of statewide significance.

4. Areas around key facilities (airports, major public utility facilities, arterial highway interchanges, etc.) in which development may have a material effect upon the facility or the surrounding community.

Activities deemed to be eligible for designation as "activities of state interest" include the following:

1. Site selection and construction of major new domestic water and sewage treatment systems and major extensions of existing domestic water and sewage treatment systems.

2. Site selection and development of solid waste disposal sites.

3. Site selection of airports.

4. Site selection of rapid or mass transit terminal, stations, and fixed guideways.

5. Site selection of arterial highways and interchanges and collector highways.

6. Site selection of major facilities of a public utility.

7. Site selection and development of new communities.

8. Efficient utilization of municipal and industrial water projects.

9. Nuclear detonations.

House Bill 1041 places primary responsibility for designation of areas and activities of state interest at the local level of government. Section 407 grants temporary emergency power to the state, exercised by the State Land Use Commission, for designation of interest areas and administration of the provisions of House Bill 1041 in extreme cases where local government has clearly abdicated its responsibility. Permits to develop in areas of state interest or to undertake activities of state interest must be obtained from the local county governments.

Senate Bill 35 gives counties the authority to approve or reject subdivision proposals. As a result, all subdivision plans must be submitted for review by designated agencies and affected municipalities. Considering the recommendations of the reviewers and the proposal by the developer, county commissioners approve or reject the applications. Modifications may be requested prior to approval.

Section 208 of the Clean Water Act (PL 92-500) provides authority and funding for planning to identify and control point and nonpoint sources of water pollution of public and private land. In the study area the Colorado West Area Council of Governments (Region VI) and Northwest Colorado Council of Governments Region XII have been designated as responsible agencies for those planning regions.

As previously stated, no areas have yet been designated as areas of state interest because legislation is still being implemented. Controls on development are imposed through use of conditional use and special use permits by county governments.

INSTITUTIONAL RELATIONSHIPS

FEDERAL

Bureau of Land Management

Development, management, use, and control of use on public lands

has been delegated to the Bureau of Land Management in the areas of federal coal development. Controls are affected through issuance or nonissuance of a variety of leases and licenses. Each authorization to use federal lands contains provisions to control that use.

BLM, in consultation with the Office of Surface Mining and the U.S. Geological Survey, formulates requirements for leases, to protect surface and non-mineral resources and to meet obligations and standards of performance required of the lessee for reclamation, as specified in 30 CFR 211.40 and 30 CFR 715. BLM and OSM also establish areas of operations for each lease, which includes mining areas as well as all areas containing structures and facilities related to mining. BLM is responsible for enforcing terms of leases outside of these areas of operation.

BLM is responsible for authorizing various ancillary facilities such as access roads, powerlines, and railroad spurs on public lands, under the Federal Land Policy and Management Act of 1976 (FLMPA). Rights-of-way are approved subject to terms indicated in 43 CFR 2800.

BLM and USGS are currently developing a Memorandum of Understanding relating to protection of paleontological resources on federal lands (see Paleontology, this chapter), the provisions of which, when completed, will serve as the basis for manangement of paleontological resources.

U.S. Geological Survey

The USGS area mining supervisor is authorized, under 30 CFR 211, to approve exploration plans, provided all necessary surface and environmental conditions have been adequately considered. Review by the Secretary of the Interior is required before approval of major federal actions significantly affecting the quality of the human environment, and is required of all new or significantly modified surface and underground mining operations on federal lease lands. The USGS is also responsible for formulating development, production, and coal recovery requirements included in mining permits, to assure that there is maximum economic recovery of the federal coal resource and that the federal government receives fair market value for the coal.

Surface Mining Reclamation and Enforcement

The Office of Surface Mining (OSM) was created to administer the requirements of the Surface Mining Control and Reclamation Act of 1977 (30 USC 1201 et seq.) for the Secretary of the Interior. One of the requirements of the Act is to cooperate with other federal agencies and state regulatory authorities to minimize duplication of inspections, enforcement, and administration of the act. The cooperative agreement negociated with the State of Colorado will be modified to meet the re-

quirements for reclamation specified by the act.

OSM, in consultation with the surface managing agency (BLM), USGS, and the regulatory authority, where applicable, recommends approval or denial of surface coal mining permit applications (which include mining and reclamation plans) to the Assistant Secretary of Energy and Minerals. OSM is the federal regulatory authority responsible, as lead agency, for reviewing coal mining and reclamation plans, enforcement of all environmental protection and reclamation standards included in an approved mining permit, the monitoring of both on- and off-site effects of the mining operation, and abandonment operations within the area of operation of a federal lease.

OSM is the principle contact for all coal mining activities within the area of operation. OSM will conduct as many inspections as are deemed necessary but no less than one partial inspection quarterly and at least one complete inspection every six months (30 CFR 721.11 (c)).

OSM, after consultaiton with BLM, USGS, and the operator establishes boundaries of the permit area for the proposed mine and approves locations of all the mine facilities located within this boundary.

The Surface Mining Control and Reclamation Act (Section 523) states that performance standards which the Secretary determines are more stringent than the federal standards should be followed in place of them. Performance standards enforced by OSM on federal leases are, therefore, at least as stringent as those required under state law or regulations. OSM and the state regulatory authority will jointly review and act on mining permit applications and recommend approval or disapproval to the officials authorized to take final action on the application.

STATE AND COUNTY

A number of State of Colorado agencies have development and administrative authority over lands owned by the state, and some have authority over some uses of public lands through issuance of state required permits, etc. The agencies responsible for approval and/or issuance of permits for various aspects of coal mining are detailed in the Required Authorization section of Chapter 1.

Except where controls have specifically been delegated by statute to counties or municipalities, Colorado retains total jurisdiction over nonpublic and privately-owned lands. Certain of these lands were conveyed to the state as part of the Act admitting Colorado to the Union. This legislation granted Sections 16 and 36 of every township to the state for educational purposes. Use and control of these lands (including mineral leasing, rights-of-way, etc.) is governed by Colorado law.

Under Colorado statutes, counties have authority to effect a wide variety of controls in matters not specifically reserved to the state. The authority applies only to those portions of the county that are unincorporated. A county may regulate and restrict location and use of buildings and structures and use, condition of use, or occupancy of lands for residency, recreation, agriculture, industry, commerce, public use, and other purposes. Cities have authority to effect a master plan, zoning, and other regulatory controls.

As indicated in the previous section, State and Local Land Use Plans, controls on development are currently exercised through conditional use and special use permits issued by county governments. These are issued on a site-specific basis, in response to use of areas which have specific values for a given locale.

CHAPTER 4

IMPACTS

This chapter describes the mid-level impacts resulting from possible future development of federal coal in the study area after the planning and environmental controls described in Chapter 3 have been implemented.

Topography

Long-term developments such as mine buildings and shop facilities, railroads, and housing developments would cause minor alterations to the topography in coal mining areas (southwest Routt County, southeast Moffat county and the area northeast of Meeker) and areas of population growth (Meeker, Craig, Hayden, and Steamboat Springs). These changes are considered permanent for the time frame of this report. These disturbances would affect 2,740 acres by 1980, an additional 4,500 acres by 1985, and an additional 6,730 acres by 1990 for a total of 8,970 acres permanently disturbed by 1990. Of this acreage, 1,140 acres would be disturbed due to the additional development of federal coal by 1980, an additional 2,315 acres by 1985, and an additional 955 acres by 1990 for a total of 4,410 acres permanently disturbed by 1990.

Mining would result in temporary disturbances to the topography in the areas of coal mining, as listed above. Existing natural surfaces would be replaced with man-made surfaces and artificial drains. Although the affected areas would be returned to their approximate original contour, the resulting angles of relief would not be as sharp, and large boulders and rock outcrops would be missing. Areas where overburden is thin would have a lower general surface, while areas which have thick overburden would be expected to have a higher general surface due to the increase in overburden bulk resulting from breaking up the original beds of rock, moving them, and dumping them (30 CFR 715.14(g)(h)). The raising or lowering of the surface would not be expected to be apparent to the casual observer. Temporary disturbance at mid-level would occur over 5,160 acres by 1980, an additional 7,310 acres by 1985, and an additional 7,330 acres by 1990 for a total of 19,800 acres. Temporary disturbances of surface area due to additional development of federal coal would be 470 acres by 1980, an additional 2,030 acres by 1985, and an additional 2,500 acres by 1990 for a total of 5,000 acres.

Subsidence and related earth fractures, including a general lowering of the surface, opening of tension cracks, and formation of compression features such as fracture bulges and small anticlines, may occur above underground mines as a result of the removal of one or more coal beds. The amount of local subsidence depends on the geometry of the mine workings, the lithology, structure, and thickness of the overburden, the direction of dip of the coal bed relative to its outcrop, and the proximity of the mine workings to the coal outcrop. Greatest subsidence normally occurs as a result of mining large blocks of coal near the coal outcrop in areas of minimal overburden. Subsidence and associated fracturing is expected to reach the surface only in those operations where the widths of the mined-out areas exceed one-fourth to one-half the height of the overburden or where barrier pillars left in place are not strong enough to support the overburden load (Zwartendyk 1971).

In the absence of specific mining plans, the magnitude of subsidence-related impacts and the area affected cannot be determined. Most underground mining in the study area would utilize continuous underground room and pillar methods (Table 1-1); only a few companies are tentatively planning to use the longwall method. Subsidence in conjunction with the room and pillar method is expected to be minimal. Some tension cracks would probably reach the surface, but no significant lowering of the surface during or following mining should occur. Subsidence as a result of the longwall method, which removes large blocks of coal and encourages roof collapse in the mined-out areas, may reach a few tens of feet, but should average less than 10 feet.

So far as could be determined, possible subsidence and related fracturing as a result of cumulative development at mid-level would jeopardize no existing structures or public roadways. Any changes in topography should be subtle and have minimal effect on surface drainage. Cracks should fill rapidly with debris and sediment and should present no greater hazard to wildlife than existing steep-sided gullies or arroyos. The effects of subsidence on ground-water are described in Water Resources.

Paleontology

Impacts to paleontological resources would consist of losses of plant, invertebrate, and vertebrate fossil materials for scientific research, public education (interpretive programs), and to other values. Losses would result from destruction, disturbance, or removal of fossil materials as a result of coal mining activities, unauthorized collection, and vandalism.

A beneficial impact of development would be the exposure of fossil materials for scientific examination and collection which otherwise may never have occurred except as a result of overburden clearance and excavation.

Losses of paleontological materials due to unauthorized collecting and vandalism would increase as population increases, but no data exists to correlate losses with general population increase.

Losses to paleontological values due to coal-related operations would occur especially in the vertebrate fossil-bearing formations in areas of coal development. These values are mammalian and other vertebrate fossils of the Wasatch and Fort Union Formations 5 to 10 miles west of Craig, Colorado, of the Fort Union and Lance Formations 10 miles northeast of Craig, and other unspecified vertebrate fossils of the Bridger Formation 5 to 10 miles south of Craig.

MINERAL RESOURCES

The major impact to mineral resources would be the removal of a cumulative total 320.65 million tons of coal from the study area by 1990. Coal production in the study area would be 20.3 million tons per year by 1980, 27.5 million tons per year by 1985, and 28.3 million tons per year by 1990. This represents 0.8 percent of the 38 billion tons of measured, indicated, and inferred coal reserves in the study area (Landis 1959). Development of additional federal coal at mid-level would account for 95.97 million tons of the total coal mined by 1990. Coal production from the development of additional federal coal would be 3.7 million tons per year by 1980, 9.3 million tons per year by 1985, and 12.4 million tons per year by 1990.

Approximately 130 million tons of coal would not be recovered because of losses inherent in the method used to extract the coal. Approximately 51 million tons of this unrecovered coal would be due to the development of additional federal coal at mid-level. Underground mining would recover approximately 50 percent of the economically minable coal, surface mining methods approximately 90 percent of the economically minable coal.

Mineral resource conflicts may occur between development of coal and development of oil and gas, and to a lesser extent, uranium. Conflicts with oil and gas rarely if ever would happen due to occurrence of resources at the same horizon; they would be based on superimposed occurrence of coal near the surface, and oil and gas at depth. Because these resources normally can be recovered sequentially without notable increase of impacts over those occurring from the recovery of one resource, the impacts of coal vs. oil and gas conflicts would be insignificant in a regional sense.

Potential conflicts between coal and uranium are not known at this time. Known occurrences of uranium, particularly in the Maybell area, are not co-extensive with coal nor attractive for development, and recovery would not jeopardize future recovery of coal. Increases in world demand and price for uranium, however, have accelerated exploration for uranium in northwestern Colorado, and now discoveries are possible. Chances are low that mining for one resource would jeopardize future mining of the other. Impacts of coal vs. uranium resource conflicts are speculative, but probably would be low. See Non Coal-Related Development, Chapter 1, for further discussion.

Ground Water

As stated in the Northwest Colorado Coal Regional Environmental Statement (NWCCRES), no significant impacts are expected to occur to the regional ground-water system in the study area. Local impacts stem from (1) removal of parts of certain aquifers, (2) interruption of premining ground-water flow by the mined areas, (3) modification of ground-water flow by replaced spoil materials, (4) changes in water quality caused by leaching of spoil materials and by exchange of water between aquifers not interconnected before mining, and (5) subsidence from underground mining.

Amplification of these impacts are based on the quantitative hydrologic relationships described in Chapter 2, Water Resources.

Removal of Parts of Certain Aquifers

A primary impact of coal mining in Northwestern Colorado would be the unavoidable local removal of parts of certain aquifers within the mined areas and the consequent effect on existing wells and springs and future ground-water development in the affected areas. Aquifers adversely affected by surface mining include (1) the mined coal beds, (2) all saturated beds and lenses of permeable sandstone in the overburden and interburden, and (3) saturated zones in overlying clinker and alluvial deposits. Underground mining would remove only the mined coal beds.

The approximate areal extent of aquifers that would be removed during the indicated time frames in this report and the relationship of the affected areas to the total area and to cumulative development at mid-level are summarized as follows (Table 4-1).

These data show that a total of 49.8 sq-mi of aquifers would be removed by 1990 as a result of cumulative development at mid-level. This is only about 4.9 percent of the shallow ground-water aquifers in the coal areas and only about 0.56 percent of the shallow ground-water aquifers in the study area. About a third of the aquifers removed by 1990 (15.8 sq-mi) would be attributable to the development of additional federal coal at mid-level.

Those parts of the coal aquifers that are removed by underground mining would not be replaced. Subsequent collapse of pillars or roof collapse induced by longwall mining would leave a rubble zone that probably would include interconnected voids for a period of many decades. If penetrated below the top of the saturated zone, these permeable rubble zones would probably yield adequate supplies of water to wells for use by livestock and wildlife. The quality of the water thus obtained should

TABLE 4-1

IMPACT OF DEVELOPMENT ON AQUIFERS

Resource	1978-80	1981-85	1986-90	1978-90
Approximate total area of aquifers removed by cumulative development at mid-level, in square miles (sq-mi)	7.4	19.4	23.0	49.8
Percent of total coal area disturbed	0.7	1.9	2.3	4.9
Percent of report area disturbed	0.08	0.22	0.26	0.56
Approximate area of aquifers removed as a result of development of additional federal coal at mid-level. (sq-mi)	1.0	5.3	9.5	15.8
Percent of total area of aquifers removed attributable to development of additional federal coal at mid-level	14	27	41	32

not be significantly different from water occurring in the coal aquifers prior to mining. Most existing wells, however, obtain their water from sandstone beds in the coal sequence. The occurrence of ground water in these sandstone aquifers should return to essentially premining conditions following the completion of mining and reestablishment of hydrologic equilibrium in the mined areas. Wells within or immediately adjacent to mined areas would probably be severely impacted during the period of mining, but these wells are few in number and comprise less than 1 percent of existing wells in the study area. Wells more than a mile from mined areas should be minimally affected.

Those parts of the coal and overlying aquifers that are removed by surface mining would be replaced by a single aquifer comprised of spoil materials. Because of the preponderance of sandstone in the coal-bearing formations in the study area, the spoil materials should be moderately permeable unless they are compacted during placement. Studies by Rahn (1975) indicate that drag-line laid spoils, which undergo gravity sorting and minimal compaction by machinery, may be as much as a hundred times more permeable than scraper-laid spoils, which are

not sorted and undergo considerable compaction by the scraper wheels. Presumably, spoils removed and placed by truck-shovel operations also would be poorly sorted and undergo appreciable compaction. Thus, drag-line laid spoil aquifers can be expected to yield larger quantities of water to wells than the combined total of the original aquifers. Conversely, scraper- or truck-laid spoils probably would have less capacity to store and transmit ground water than the removed aquifers. Compacted spoils can be expected to yield as little as 1 gallon per minute (gpm) to wells; permeable drag-line laid spoils may yield as much as 100 gpm.

Interruption of Premining Ground-Water Flow

Water pumped from both surface and underground mines would create a new sink or low point in the ground-water flow system. The effect would be to interrupt natural ground-water movement through the mine areas toward points of natural ground-water discharge, usually the nearest incised valley holding a perennial or intermittent stream. As a result, water levels in the affected aquifers would be lowered in the vicinity of the mines. Additional lowering of water levels would occur in the vicinity of those mines where wells are pumped to supply water for mining operations.

The magnitude of water-level declines in the vicinity of mines would depend on aquifer properties, recharge characteristics, rate of pumping, and duration of pumping, but declines probably would not generally exceed 100 feet within the mined areas and should not exceed 10 feet more than a mile from the mined areas. Impacts on most existing wells should be generally small, reducing well yields by less than 10 percent. Few springs occur in and adjacent to the mined areas. Most water used in mining operations (approximately 10 gallons per ton of coal produced, Table 1-9) would be obtained from impounding surface runoff or from dewatering active pits and not from wells. Should any nearby domestic or stockwater wells be significantly impacted, the responsible mining company must replace the interrupted supplies.

Dewatering of those mines that extend below the level of nearby perennial or intermittent streams could cause a reversal of the hydraulic gradient in the immediate vicinity of the mines so that water would tend to move from the streams toward the mines instead of from the mines toward the streams. A reduction in stream flow could result, but the magnitude should be small and should not significantly impact any of the principal streams in the report area because of the restrictions placed on mining on alluvial valley floors and within 100 feet of intermittent or perennial streams. The impact on streamflow stemming from the interruption of ground-water flow by coal mining is discussed under Surface Water.

The area affected by dewatering of mines and by coal-related development of the ground-water resource should be general proportional to coal production. On that basis, impacts attributable to development of additional federal coal at mid-level should comprise about 18 percent of the total by 1980, about 34 percent by 1985, and about 44 percent by 1990.

Modification of Flow by Replaced Spoil Materials

Relatively impermeable shale interbedded with the sandstone and coal gives rise to perched ground-water conditions in many, if not most, of the coal areas in northwestern Colorado. Removal of these perching layers and replacement of the mined interval in surface mined areas with spoil materials that should have much higher vertical permeability than the premining stratigraphic sequence would tend to eliminate this ground-water perching. The effect would be to reduce the amount of ground water moving laterally on top of perching layers toward discharge areas along nearby valley side slopes (described in Chapter 2) and to increase ground-water recharge to depth. As a result, vegetation along the valley side slopes would be locally deprived of part or all of this additional moisture and would readjust accordingly in vigor, density, and type. Increased ground-water recharge to depth would cause increased leaching of spoils materials and eventual transport of these leached materials into the surface-water system.

Selective placement and compaction of backfilled materials as required by 30 CFR 715.14 (j)(2) would theoretically mitigate these impacts, but no restoration of perched ground-water conditions by compaction has been achieved to date. Given the complexities of most natural ground-water systems and the technological complications introduced by selectively placing and compacting backfill materials segment by segment as mining progresses, it appears very probable that at most mining operations the impacts identified above would be only partially mitigated.

Changes in Water Quality

As ground water percolates through the replaced spoil materials, entering at the surface or from aquifers truncated by the mining operations, solution and interaction with soluble minerals in the spoil materials are expected to significantly change the quality of the local ground-water resource. Although definite analytical data are lacking from which to predict the effects of leaching on water quality, some inferences can be drawn from known effects of several ongoing mining operations on local water quality.

Water-quality studies at the Energy Fuels and Edna Mines in the eastern part of the report area by Colorado School of Mines Research

Institute and Engineering Enterprises, Inc. (1976) and by McWhorter and Skogerboe (1975) show that ground water in or discharging from the spoils generally contains 2,500 to 3,000 milligrams per liter (mg/l) dissolved solids. These concentrations are approximately double the dissolved solids content of ground water locally in undisturbed aquifers. Similar results are reported in southeastern Montana by Van Voast and Hedges (1975) where dissolved solids concentrations in spoil waters, although higher than in northwestern Colorado, averaged about two to three times those in undisturbed coal aquifers.

Water in the spoil materials is predominantly a calcium sulfate type with lesser amounts of magnesium, sodium, and bicarbonate. The higher concentration of dissolved solids in water in the spoils compared to water in undisturbed aquifers in the Mesa Verde Group is attributable largely to higher levels of calcium, magnesium, and sulfate. Possible sources of these ions are described in the NWCCRES (p. III-4). This water would be generally unsuitable for domestic use but should have no deleterious effects on livestock and wildlife.

Selective placement and compaction of backfilled materials as required by 30 CFR 715.14 (j)(2) should prevent virtually all leaching of spoil materials placed above the top of the postmining saturated zone. Some percolation of ground water into these spoils may occur from perched zones in adjacent undisturbed rocks but consequent leaching would be very local and should have no significant impact on the environment.

Conversely, spoils placed below the top of the postmining saturated zone would be subject to leaching by inflow from truncated aquifers unless the entire periphery and surface of the spoil materials were compacted. In that event the water level in the spoil materials eventually would rise and stand at the level of the saturated zone in the adjacent bedrock, but ground-water movement through the spoils would be so slow as to have virtually no significant adverse impact outside the mined areas.

Aquifers truncated by mining below the top of the saturated zone that were not hydraulically connected before mining would be connected through the saturated mine fill after mining and reclamation. Compaction of the fill around the periphery of the mined area would minimize circulation between such aquifers, but premining head differences between aquifers would probably be largely eliminated. Local changes in hydraulic gradients, however, would probably be insignificant when considering the total aquifer system.

Effects of Subsidence from Underground Mining

Subsidence both during and following the completion of underground mining can introduce shear stresses in the overlying rocks that eventually may cause local rupture in many, if not most, of these mined areas. Cracks

thus formed commonly extend upward to the surface and would open all intersected aquifers to intercirculation of ground water and equalization of hydraulic pressures. Upper perched zones may be drained, adversely impacting some local wells and springs. Available data indicate that less than 1 percent of existing wells and springs in the study area would be adversely affected by subsidence. Mixing of waters could locally degrade water quality in some aquifers by increasing dissolved solids content to as much as 3,000 mg/l. These waters would be suitable for use by livestock and wildlife but would be unsuitable for domestic use. Such impacts would be long term.

Surface Water

Impacts of coal mining in northwestern Colorado on the surface-water system include (1) alteration or removal of all existing stream channels within those areas disturbed by surface mining, (2) effects of subsidence from underground mining on surface drainage, (3) interception and diversion of run-off and consequent reduction in discharge downstream, (4) consumptive use of water, (5) degradation in water quality, and (6) effects of erosion and sedimentation.

Alteration or Removal of Existing Stream Channels

A primary impact of surface mining and of surface disturbances in conjunction with surface and underground mining in northwestern Colorado would be the alteration or removal of all natural stream channels within disturbed areas. Because of the restrictions or limitations on mining on alluvial valley floors and within 100 feet of perennial or intermittent streams, only ephemeral stream channels probably would be significantly impacted.

Regulations (30 CFR 715.17 (d) and 717.17 (d)) require that new channels must maintain average stream gradients and remain stable to the extent possible using the best technology currently available. This wording recognizes that current technology is not adequate to permit reestablishment of channels that would be as stable as those draining the premining surface. Reconstructed channels generally can be expected to undergo a prolonged period of geomorphic readjustment before reaching quasi-equilibrium with natural flow conditions. Reconstruction of postmining channels to premining dimensions would not assure stability because of changes in runoff from the reclaimed surface.

Assuming that areas disturbed by mining have approximately the same average drainage density as the overall coal areas, the length of channels altered or removed should be proportional to the areas disturbed. Accordingly, the percentage of stream channels affected during the time frames indicated in this report are as follows (Table 4-2).

TABLE 4-2

STREAM CHANNELS AFFECTED BY DEVELOPMENT

Resource	1978-80	1981-85	1986-90	1978-90
Approximate total surface area disturbed at mid-level (from Table 1-6) (sq-mi)	12.3	18.4	14.2	45.0
Percent of total coal area in which stream channels would be altered or removed	1.2	1.8	1.4	4.5
Percent of study area in which stream channels would be altered or removed	0.14	0.21	0.16	0.51
Approximate surface area disturbed as a result of development of additional federal coal at mid-level (sq-mi)	2.5	6.8	5.4	14.7
Percent of total surface area disturbed attributable to development of additional federal coal at mid-level	20	37	38	33

Clearly, alteration or removal of stream channels from only 0.51 percent of the study area by 1990 should not constitute a significant impact on the regional surface-water system, given the relatively small area disturbed, the protection afforded perennial and intermittent streams, and the required efforts to reconstruct stable channels in reclaimed areas. Impacts incurred from possible failure to reconstruct stable channels should be primarily local in nature.

Effects of Subsidence from Underground Mining on Surface Drainage

Underground mining by continuous and conventional room and pillar methods should cause little or no subsidence at the surface. Any consequent changes in channel geometry should be very minor and short-lived inasmuch as these channels are continuously readjusting their size, shape, gradient, etc., to maintain approximate equilibrium with fluctuating flow conditions. Any cracks intersecting stream channels would be rapidly filled with sediment, introducing little or no changes in channel geometry.

Conversely, underground mining by longwall methods could cause significant local subsidence. At mid-level development, however, only Northern Minerals Company proposes to use the longwall method. The area that would be affected is in the precipitous terrain immediately west of Curtis Creek about 5 miles north of Meeker, Colorado (Chapter 1, Northern Minerals Company). Channels in this area are small, incised in bedrock, and have gradients averaging 1,000 to 2,000 feet per mile. The anticipated subsidence from longwall mining should have little or no impact on these existing channels. Mining would not extend beneath Curtis Creek Valley and, therefore, would not disrupt this principal drainage or any of its larger tributaries.

Interception and Diversion of Runoff

Unless the total disturbed area is small and the permittee can show that sedimentation ponds are not necessary to meet effluent limitations, regulations require that all surface drainage from areas disturbed by coal mining (including reclaimed areas) must be passed through a sedimentation pond or a series of ponds before leaving the permit area (30 CFR 715.17 (a) and 717.17 (a)). Although this regulation mitigates increased sediment yield downstream, the sedimentation ponds and other temporary and permanent impoundments constructed in conjunction with coal mining operations also store water and thereby increase evapotranspiration losses. The effect would be to reduce runoff downstream during the life of the structures.

Data are not available to calculate the magnitude of these losses, but they should be generally insignificant compared to water yield from the report area. For example, if all runoff from areas disturbed directly by coal mining activities were stored in reservoirs, the loss to downstream flow should average about 43 ac-ft/sq-mi of disturbed area (Chapter 2, Water Resources). The relationship of this maximum probable water loss to total water yield from the basin is shown in Table 4-3.

Actual water losses from storage in impoundments and sedimentation ponds by 1990 would probably average less than 0.05 percent of total runoff from the watershed. Although the loss of this water would be localized and not distributed uniformly over the entire study area, it is unlikely that these water losses would significantly impact existing water rights in any given area. Regulations (30 CFR 715.17(i) and 717.17(i)) require that a permittee replace the water supply of an owner where that supply has been significantly affected by contamination, diminution, or interruption as a result of coal mine operations by the permittee.

TABLE 4-3

MAXIMUM PROBABLE WATER LOSS DUE TO DEVELOPMENT

Source of loss	1980	1985	1990
Annual maximum water loss from disturbed areas (ac-ft) attributable to cumulative development at mid-level	300	840	1,330
Percent of annual runoff from study area	0.02	0.06	0.09
Annual maximum water loss attributable to additional federal coal at mid-level	60	220	380
Percent of total water loss attributable to additional federal coal at mid-level	20	26	29

Offsetting the small adverse impact of this water loss to the Colorado River system would be the added source of water provided by the impoundments for wildlife and for livestock in those areas where grazing is permitted.

Data are not adequate from which to appraise the effect of sedimentation ponds on the base or low flow of streams in the coal areas. Water pumped from mines into sedimentation ponds can be expected to dewater aquifers locally and thereby reduce natural ground-water discharge to streams in the vicinity of the mines. The effect would be to reduce the base flow of these streams. In practice, however, ground-water discharged from a mining operation in quantities sufficiently large to diminish the base flow of nearby streams would soon fill a sedimentation pond to the level of the outflow pipe and all outflow would then contribute directly to base flow downstream. At the same time the sedimentation ponds would intercept snowmelt runoff or storm runoff and prolong the period of flow. The effect would be to increase base flow downstream. The net effect, although uncertain, probably would be a slight increase in the base flow of affected streams. Larger streams and rivers in the study area would not be measurably affected.

Similarly, available data do not permit an appraisal of the effects of these inferred water losses in conjunction with the operation of sedimentation ponds on ground-water recharge in downgradient areas. Because of the characteristically steep hydraulic gradients in the downdip direction in the coal areas, however, most ground-water movement appears to be laterally toward incised stream valleys rather than downdip (Chapter 2, Water Resources). Consequently, any reduction in ground-water recharge to downgradient areas should be very local and should return to at least premining rates on completion of mining and reclamation.

Consumptive Use of Water

Expansion of coal-mining operations in northwestern Colorado would slightly increase the consumptive use of water in the area and, consequently, would reduce discharge downstream to the Colorado Rivers system where any reduction in flow is considered to be a serious impact. Legal constraints to utilization of Colorado River water and apportionment of the water between the Upper and Lower Basins is described in the NWCCRES, p. II-24.

Consumptive uses are listed in Table 4-4. Computations indicate that cumulative development at mid-level would decrease annual water yield from the Yampa sub-basin by about 1.2 percent by 1980, increasing to about 1.7 percent by 1985 and remaining at that level through 1990. Development of additional federal coal at mid-level alone would decrease annual water yield from the Yampa subbasin by about 0.2 percent by 1980, increasing to about 0.4 percent by 1985, and remaining at that level through 1990. Consumptive use of this amount of water would not violate terms of the Colorado River Basin Contract inasmuch as the Upper Basin States are not yet using their alloted amount of river water. Neverthless this consumptive use would reduce the amount of water available for other beneficial uses downstream. Consumptive use of water attributable to cumulative development of the coal resource at mid-level should not adversely affect any other uses of water in the study area inasmuch as flow in the Yampa River is more than adequate for local uses.

Degradation in Water Quality

Increased municipal wastes, leaching of spoils materials, and water pumped from the mines into streams as a result of cumulative development at mid-level would slightly degrade the quality of water yielded by the study area (Table 4-4). Computations indicate that development of additional federal coal at mid-level would increase the weighted average of dissolved solids in the Yampa River by about 0.2 percent by 1980, by about 0.5 percent by 1985, and by about 0.8 percent by 1990. Consequent increase in dissolved solids concentration in the Colorado River below Hoover Dam would be about 0.1 mg/l by 1980, about 0.5 mg/l by 1985, and about 0.6 mg/l by 1990. The increase in weighted average of dissolved solids in the Yampa River and the increase in dissolved solids concentration in the Colorado River below Hoover Dam for the same time periods without the development of additional federal coal at mid-level are given in Table 8-8.

Effects of Erosion and Sedimentation

Changes in sediment yield stemming from surface disturbances directly and indirectly associated with coal mining in northwestern

TABLE 4-4

SOURCES AND ESTIMATES OF CONSUMPTIVE USE AND POLLUTION IN YAMPA RIVER SUBBASIN 1/

Item No.	Item	Present	1980	1985	1990
1	Total undepleted supply (ac-ft): 2/	1,702,400	1,702,400	1,702,400	1,702,400
2	Consumptive use at low-level development (Table 8-8) (ac-ft)	116,100	130,200	188,100	195,000
3	Net discharge at low-level development (ac-ft)	1,586,300	1,572,200	1,514,300	1,507,400
4	Additional consumptive use attributable to development of additional federal coal at mid-levl				
5	Additional power plant (Craig 3) (ac-ft)	--	--	5,700	5,700
6	Municipal and rural (ac-ft) 3/	--	170	620	850
7	Mining operations (ac-ft)	--	110	280	380
8	Total (sum of lines 5, 6, and 7) (ac-ft)	--	280	6,600	6,930
9	Net discharge at cumulative mid-level development (line 3 less line 8) (ac-ft) 4/	1,586,300	1,571,900	1,507,700	1,500,500
10	Dissolved solids in Yampa River at low-level development (Table 8-8) (tons)	420,400	420,400	437,700	438,800
11	Additional increase in dissolved solids load attributable to development of additional federal coal at mid-level				
12	Municipal wastes (tons) 5/	--	110	380	460
13	Mining operations (tons)	--	500	1,000	2,000
14	Less load removed by consumptive use of water for Craig 3 power plant (tons)	--	--	-1,250	-1,250
15	Total (sum of lines 12, 13, and 14) (tons)	--	610	130	1,210
16	Net dissolved solids load in Yampa River at cumulative mid-level development (line 10 plus line 15) (tons)	420,400	421,000	437,800	440,000
17	Discharge weighted average of dissolved solids in Yampa River at low-level development (Table 8-8) (mg/l)	194.9	196.7	212.6	214.1
18	Discharge weighted average of dissolved solids in Yampa River at cumulative mid-level development (mg/l)	194.9	197.0	213.6	215.7
19	Increase in dissolved solids in Yampa River as a result of development of additional federal coal at mid-level (mg/l)	0 6/	0.3	1.0	1.6
20	Increase in dissolved solids in Colorado River below Hoover Dam at low-level development (mg/l) 7/	0 6/	1.0	6.4	7.0
21	Increase in dissolved solids in Colorado River below Hoover Dam at cumulative mid-level development (mg/l) (7/	0 6/	1.1	6.9	7.6
22	Increase in dissolved solids in Colorado River below Hoover Dam as a result of development of additional federal coal at mid-level (mg/l)	0 6/	0.1	0.5	0.6

1/ Update from Table RII-7, NWCCRES
2/ Irons and others, 1965.
3/ Based on use of 150 gal/day/person with 50 gal/day consumed and 100 gal/day returned to streams as sewage. Population projections from Table 1-5.
4/ No action other than power plants under construction.
5/ Based on 100 gal/sewage/day/person and increase in dissolved solids load of 200 mg/l.
6/ Present is assumed to be base level against which future changes are compared.
7/ Includes both the effects of diversions and increased dissolved solids loading.

Colorado range widely depending on required mitigation measures. For example, runoff from areas disturbed by surface mining or by surface activities associated with underground mining must not transport more than 30 mg/l total suspended solids as an average of daily values for 30 consecutive discharge days (30 CFR 715.17 (a) and 717.17 (a)). The effect is to reduce sediment yield from these areas to less than 5 percent of premining rates. In contrast, existing rules and regulations generally do not apply to activities stemming indirectly from coal mining such as housing construction and related urbanization. Increased sediment yield from increased population (Table 1-5) would be virtually unmitigated.

Estimated sediment yields as a result of mining and associated activities at cumulative mid-level development for the time frames addressed in this report are listed in Tables 4-5, 4-6, and 4-7. Results indicate that sediment yield from all disturbed areas would increase about 250 percent during 1978-80, about 220 percent during 1981-85, and would decrease about 10 percent during 1986-90. The lesser sediment yield during the latter period is attributed to fewer acres disturbed by new activities, to reclamation of most of the areas disturbed during the period 1978-85, and to limitation of suspended solids in runoff from mined and reclaimed areas as described above.

The significance of this increased sediment yield can be shown by a comparison with the suspended sediment load in the Yampa River near Maybell (Table 2-9), which averages about 300,000 tons per year. Thus, if all the sediment derived from erosion as a consequence of cumulative coal development at mid-level were to enter the river net and move downstream, which is highly unlikely, the sediment load in the Yampa River would increase by about 0.9 percent by 1980, by about 3.0 percent by 1985, and would be reduced by about 0.4 percent by 1990. These changes are insignificant compared to annual and seasonal fluctuations in sediment load in the Yampa River and should have no measurable affect on water and sewage treatment facilities. Locally increased sedimentation during the construction of power plants, roads, railroads, and housing developments would cause some short-term loss of habitat for aquatic biology (see Aquatic Biology).

Estimated sediment yields as a result of development of additional federal coal at mid-level are listed in Tables 4-8, 4-9, and 4-10. Results show that the change in sediment yield attributable to mining additional federal coal at mid-level would be about 44 percent of the total change at cumulative mid-level development during the period 1978-80 and about 60 percent during the period 1981-85. During the period 1986-90, however, the change in sediment yield stemming from the development of additional federal coal at mid-level would actually exceed the total sediment yield at cumulative mid-level development (Table 4-11).

This apparent anomaly occurs because the total acreage disturbed by development of additional federal coal at mid-level (Table 1-4) contains

TABLE 4-5

ESTIMATED SEDIMENT YIELD AS A RESULT OF MINING AND ASSOCIATED ACTIVITIES AT CUMULATIVE MID-LEVEL DEVELOPMENT
1978-80

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines	3,280	770	30	-740
Surface mine facilities and related R/W 1/	700	160	6	-154
Underground mines and related R/W 1/	520	120	4	-116
Power lines	1,880	440	1,410	+970
Power plants	0	0	0	0
Roads	630	150	940	+790
Railroads	490	110	1,030	+920
Population related disturbances	400	90	1,200	+1,110
Total	7,900	1,840	4,620	+2,780

1/ R/W, rights of way.

TABLE 4-6

ESTIMATED SEDIMENT YIELD AS A RESULT OF MINING AND ASSOCIATED ACTIVITIES AT CUMULATIVE MID-LEVEL DEVELOPMENT
1981-85

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines, new	7,310	2,860	100	-2,760
Surface mines, existing	3,280	1,280	45	-1,235
Surface mine facilities, new	300	120	4	- 116
Surface mine facilities, existing	700	270	10	- 260
Underground mines, new	400	160	5	- 155
Underground mines, existing	520	200	7	- 193
Power lines, new	0	0	0	0
Power lines, existing	1,880	730	940	+ 210
Power plants, new	380	150	950	+ 800
Power plants, existing	0	0	0	0
Roads, new	1,050	410	2,620	+2,210
Roads, existing	630	250	630	+ 380
Railroads, new	500	160	1,750	+1,590
Railroads, existing	490	190	250	+ 60
Population related disturbances, new	1,870	730	9,350	+8,620
Population related disturbances, existing	400	160	80	- 80
Total	19,710	7,670	16,741	+9,071

TABLE 4-7

ESTIMATED SEDIMENT YIELD AS A RESULT OF MINING AND ASSOCIATED ACTIVITIES AT CUMULATIVE MID-LEVEL DEVELOPMENT
1986-90

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines, new	7,330	2,860	100	-2,760
Surface mines, existing	10,590	4,140	140	-4,000
Surface mine facilities, new	0	0	0	0
Surface mine facilities, existing	1,000	390	14	- 376
Underground mines, new	0	0	0	0
Underground mines, existing	920	360	13	- 347
Power lines, new	0	0	0	0
Power lines, existing	1,880	730	940	+ 210
Power plants, new	0	0	0	0
Power plants existing	380	150	380	+ 230
Roads, new	1,050	410	2,620	+2,210
Roads, existing	1,680	660	1,680	+1,020
Railroads, new	100	40	350	+ 310
Railroads, existing	990	390	500	+ 110
Population related disturbances, new	580	230	2,900	+2,670
Population related disturbances, existing	2,270	890	445	- 445
Total	28,770	11,250	10,082	-1,168

TABLE 4-8

ESTIMATED SEDIMENT YIELD AS A RESULT OF DEVELOPMENT OF ADDITIONAL FEDERAL COAL AND ASSOCIATED ACTIVITIES AT MID-LEVEL DEVELOPMENT
1978-80

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines	470	110	4	- 106
Surface mine facilities and related R/W 1/	0	0	0	0
Underground mines and related R/W 1/	400	90	3	- 87
Power lines	0	0	0	0
Power plants	0	0	0	0
Roads	420	100	630	+ 530
Railroads	0	0	0	0
Population related disturbances	320	70	960	+ 890
Total	1,610	370	1,597	+1,227

1/ R/W, rights-of-way.

TABLE 4-9

ESTIMATED SEDIMENT YIELD AS A RESULT OF DEVELOPMENT OF ADDITIONAL FEDERAL COAL AND ASSOCIATED ACTIVITIES AT MID-LEVEL DEVELOPMENT
1981-85

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines, new	2,030	790	28	- 762
Surface mines, existing	470	180	6	- 174
Surface mine facilities, new	100	40	1	- 39
Surface mine facilities, existing	0	0	0	0
Underground mines, new	200	80	3	- 77
Underground mines, existing	400	160	5	- 155
Power lines, new	0	0	0	0
Power lines, existing	0	0	0	0
Power plants, new	380	150	950	+ 800
Power plants, existing	0	0	0	0
Roads, new	630	250	1,580	+1,330
Roads, existing	420	160	420	+ 260
Railroads, new	225	90	790	+ 700
Railroads, existing	0	0	0	0
Population related disturbances, new	780	300	3,900	+3,600
Population related disturbances, existing	320	120	60	- 60
Total	5,955	2,320	7,743	+5,423

TABLE 4-10

ESTIMATED SEDIMENT YIELD AS A RESULT OF DEVELOPMENT OF ADDITIONAL FEDERAL COAL AND ASSOCIATED ACTIVITIES AT MID-LEVEL DEVELOPMENT
1986-90

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines, new	2,500	980	34	- 946
Surface mines, existing	2,550	1,000	35	- 965
Surface mine facilities, new	0	0	0	0
Surface mine facilities, existing	100	40	1	- 39
Underground mines, new	0	0	0	0
Underground mines, existing	600	230	8	- 222
Power lines, new	0	0	0	0
Power lines, existing	0	0	0	0
Power plants, new	0	0	0	0
Power plants, existing	380	150	380	+ 230
Roads, new	525	210	1,310	+1,100
Roads, existing	1,050	410	1,050	+ 640
Railroads, new	0	0	0	0
Railroads, existing	225	90	110	+ 20
Population related disturbances, new	430	170	2,150	+1,980
Population related disturbances, existing	1,100	430	215	- 215
Total	9,460	3,710	5,293	+1,583

a significantly lower percentage of mined lands from which sediment yield would be controlled by sedimentation ponds than does the cumulative mid-level scenario (Table 1-6). The effect of using sedimentation ponds to reduce sediment yield is shown in Tables 4-5 to 4-10. For example cumulative development of coal at mid-level for the period 1978-90 (Tables 4-5 to 4-7) is expected to increase total sediment yield from about 20,760 tons before disturbance to about 31,450 tons as a result of disturbance, an increase in sediment yield of about 51 percent. Without sedimentation ponds to reduce sediment yield from areas disturbed directly by mining or by mining related activities, total sediment yield for the period would probably exceed 69,000 tons, an increase of at least 230 percent over the sediment yield without mining.

Development of additional federal coal at mid-level for the period 1978-90 (Tables 4-8 to 4-10) is expected to increase total sediment yield from about 6,400 tons before disturbance to about 14,600 tons as a result of disturbance, an increase in sediment yield of about 128 percent. Without the use of sedimentation ponds, total sediment yield for the period would probably exceed 22,000 tons, an increase of at least 240 percent over the sediment yield without mining.

TABLE 4-11

CHANGE IN SEDIMENT YIELD ATTRIBUTABLE TO MID-LEVEL DEVELOPMENT

	1978-80	1981-85	1986-90	1978-90
Total change in sediment yield attributable to cumulative mid-level development (Tables 4-5 to 4-7) (tons)	+2,780	+9,071	-1,168	+10,683
Change in sediment yield attributable to development of additional federal coal at mid-level (Tables 4-8 to 4-10) (tons)	+1,227	+5,423	+1,583	+ 8,233
Relationship of change in sediment yield attributable to development of additional federal coal to cumulative development of coal at mid-level (percent)	44	60	--	77

The effect on air quality of a certain action can be predicted by estimating the amount of pollutants released to the atmosphere by that action and using this as input data to a computerized atmospheric dispersion model. The model is used to calculate the change in ambient pollutant concentrations at specified points around the source.

The impacts on the ambient concentrations of total suspended particulates (TSP), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and non-methane hydrocarbons (NMHC) are examined for 1980, 1985, and 1990. The pollutant concentrations are compared to the national and Colorado ambient air quality standards and to the increments of increase of pollution permissible under standards for prevention of significant deterioration of air quality (PSD).

Emissions

In order to use the computerized air quality model, the quantity of each pollutant emitted to the atmosphere by a given source must be known. Emissions are estimated for four different types of sources - surface and underground coal mines, towns, transportation, and major point sources in the study area.

Surface coal mines are the major source of emissions of particulate matter (PM) in the study area. Operations within a surface mine which contribute to fugitive dust emissions include draglines, blasting, wind erosion of exposed areas, topsoil removal, handling of coal and overburden, and haul road traffic.

Underground coal mines in the study area also contribute significant amounts of particulate emissions, from activities such as coal loading, conveying, transferring, crushing, and hauling.

Information on the operation of coal mining was obtained from individual mining and reclamation (M&R) plans when it was available. Where information was not available certain assumptions were made about mining operations.

The annual emissions of particulate matter from development of coal at mid-level for 1980, 1985, and 1990 are shown in Table 4-12.

Only small amounts of pollutants are released from vehicles, steam generators, and other combustion sources operating within the coal mines. Because of this, effects on surrounding air quality would be expected to be insignificant (U.S. Department of Interior 1976).

Major towns in the study area would have a significant effect on the regional air quality for TSP, NO_2, CO, and NMHC. Current emissions data for these pollutants were taken form the National Emissions Data System (NEDS) Inventory for 1977 (U.S. Environmental Protection Agency 1978b). Pollutant emissions for each town in the study area were estimated from the total emissions for its county, in proportion to the county population in each town. The 1980, 1985, and 1990 emissions from the towns were predicted to increase in direct proportion to projected growth in the population of the towns between 1977 and 1980, 1985, and 1990. The PM, NO_2, CO, and NMHC emissions from the towns are listed in Table 4-13.

Traffic on major highways within the study region contributes emissions of particulates, oxides of nitrogen (NO_x), CO, and NMHC. Although no significant increases in emissions of these pollutants would occur as a result of coal development, emissions from vehicles using major highways would contribute slightly to ambient pollutant levels in 1980, 1985, and 1990 (Table 4-14). Major highway segments examined in the analysis are shown in Map 4-1.

A number of major point sources of particulates, sulfur dioxide (SO_2), NO_x, CO, or NMHC are located in the study area. Sources of pollutants that could possibly interact with emissions resulting from coal development and associated population growth were identified (Table 4-15). They were obtained primarily from point source emissions inventories for northwest Colorado counties (Colorado Air Pollution Control Division 1978).

Railroads serve existing coal mines in northwest Colorado, primarily transporting coal to eastern Colorado and beyond. The number of unit trains transporting coal would be expected to increase in 1980, 1985, and 1990. Construction of railroad lines and operation of unit trains along existing and proposed tracks would continue to be a source of fugitive dust emissions. Fugitive dust emissions from the construction of these lines, however, should be small and have no significant effect on regional TSP concentrations. In addition, emissions from trains would be intermittent and their impact would be expected to be site-specific.

TABLE 4-12

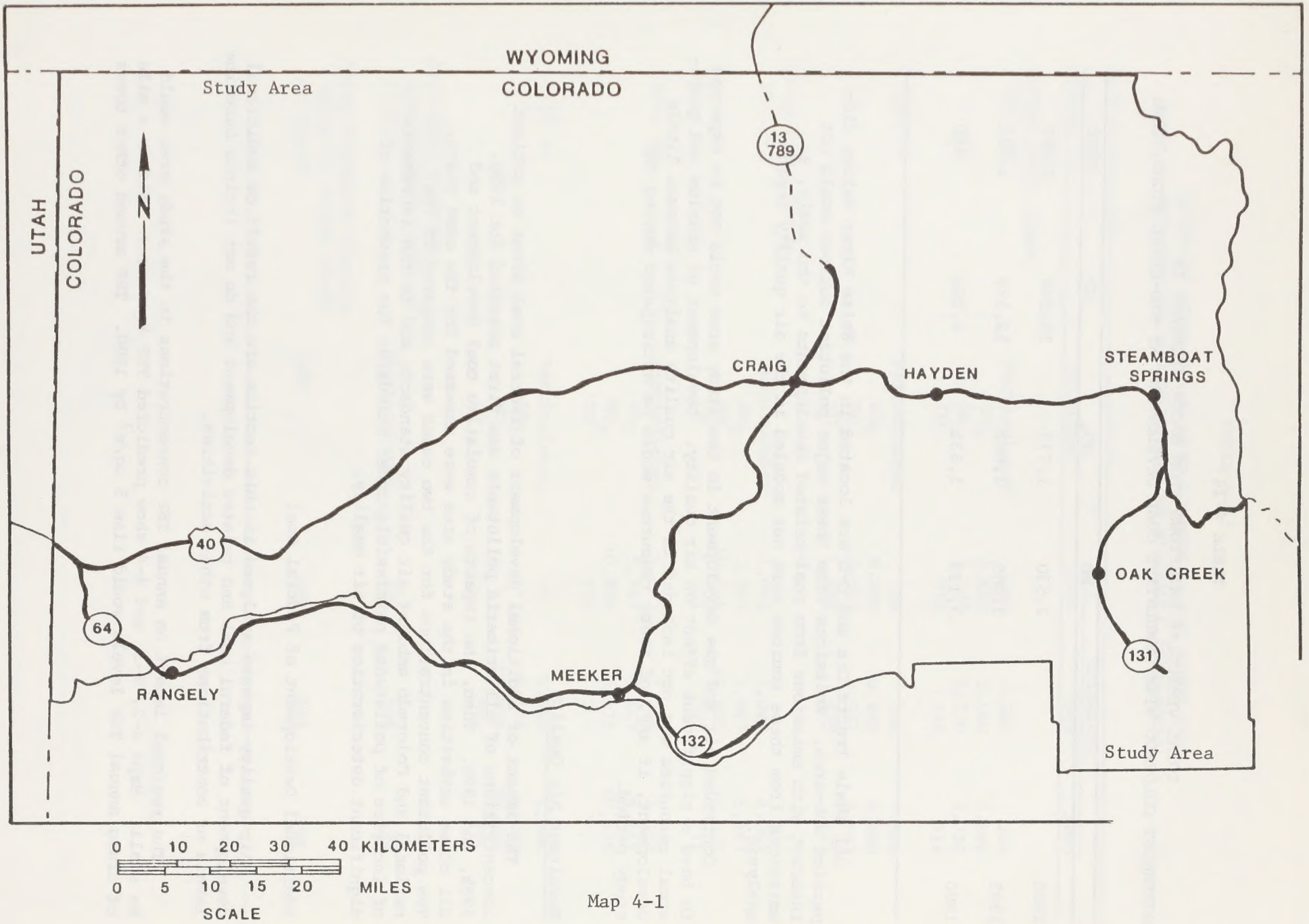
PARTICULATE EMISSIONS FROM COAL MINES IN THE STUDY AREA (TONS/YEAR) AT MID-LEVEL

	1980	1985	1990
Cumulative development	16,786	19,378	18,108
Additional development of federal coal	3,465	7,129	7,978

TABLE 4-13

POLLUTANT EMISSIONS FROM TOWNS IN NORTHWEST COLORADO
WITH CUMULATIVE COAL DEVELOPMENT AT MID-LEVEL (TONS/YEAR)

Town	Pollutant	1980	1985	1990
Craig	PM	34	65	87
	NO_x	274	509	695
	CO	2,328	4,309	5,895
	NMHC	446	825	1,129
Steamboat Springs	PM	48	86	114
	NO_x	348	612	826
	CO	1,925	3,416	4,620
	NMHC	454	801	1,083
Meeker	PM	65	134	125
	NO_x	427	886	822
	CO	2,303	4,789	4,437
	NMHC	506	1,050	975
Rangely	PM	30	67	63
	NO_x	193	439	413
	CO	1,045	2,367	2,232
	NMHC	229	519	491
Hayden	PM	18	37	50
	NO_x	134	267	409
	CO	746	1,495	2,283
	NMHC	174	349	534
Oak Creek	PM	8	16	24
	NO_x	52	116	169
	CO	289	647	945
	NMHC	68	152	222



Map 4-1

HIGHWAY SEGMENTS FOR WHICH EMISSIONS ARE CALCULATED

TABLE 4-14

TOTAL VEHICULAR EMISSIONS FROM MAJOR HIGHWAYS IN NORTHWEST COLORADO WITH CUMULATIVE COAL DEVELOPMENT AT MID-LEVEL (TONS/YEAR)

	PM	NO_x	CO	NMHC
1980	2,530	1,773	19,334	2,060
1985	3,069	1,682	12,124	1,011
1990	3,123	1,531	6,263	480

Oil shale Tracts C-a and C-b are located in the White River Valley dispersion sub-area. Emissions from these major pollutant sources would not interact with emissions from coal-related developments to the north, so emissions from these sources were not modeled in the air quality impact analysis.

Continued oil and gas development in the study area would not be expected to have a significant effect on air quality. Development of uranium and geothermal resources was not included in the air quality analysis because little development, if any, of these resources would be anticipated during the study period.

Resultant Air Quality

The impact of additional development of federal coal alone on ambient concentrations of all criteria pollutants was first assessed for 1980, 1985, and 1990. Then, the impacts of cumulative coal development and all other activities in the study area were assessed for the same years. The pollutant concentrations for the two cases were compared to the national and Colorado ambient air quality standards and to the increments of increase of pollutants permissible under standards for prevention of significant deterioration of air quality.

Additional Development of Federal Coal

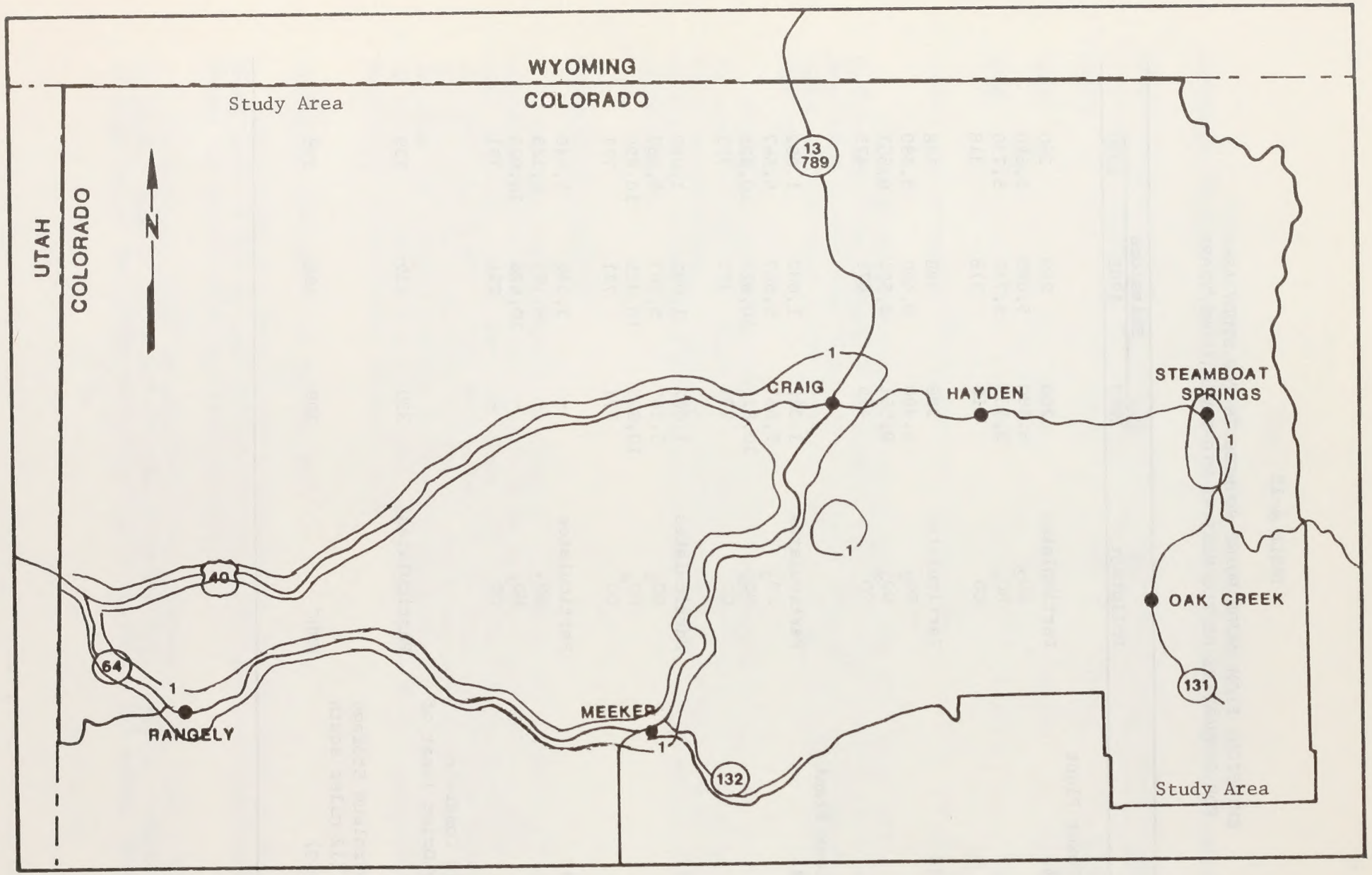
Air quality impacts analyzed in this section are the result of additional development of federal coal and related development and do not include baseline levels or contributions from other activities.

The regional impact on annual TSP concentrations in the study area would be small. Maps 4-2, 4-3, and 4-4 show predicted TSP increases. Within a mile of Craig annual TSP levels would rise 5 ug/m^3 by 1990. TSP around other towns

TABLE 4-15

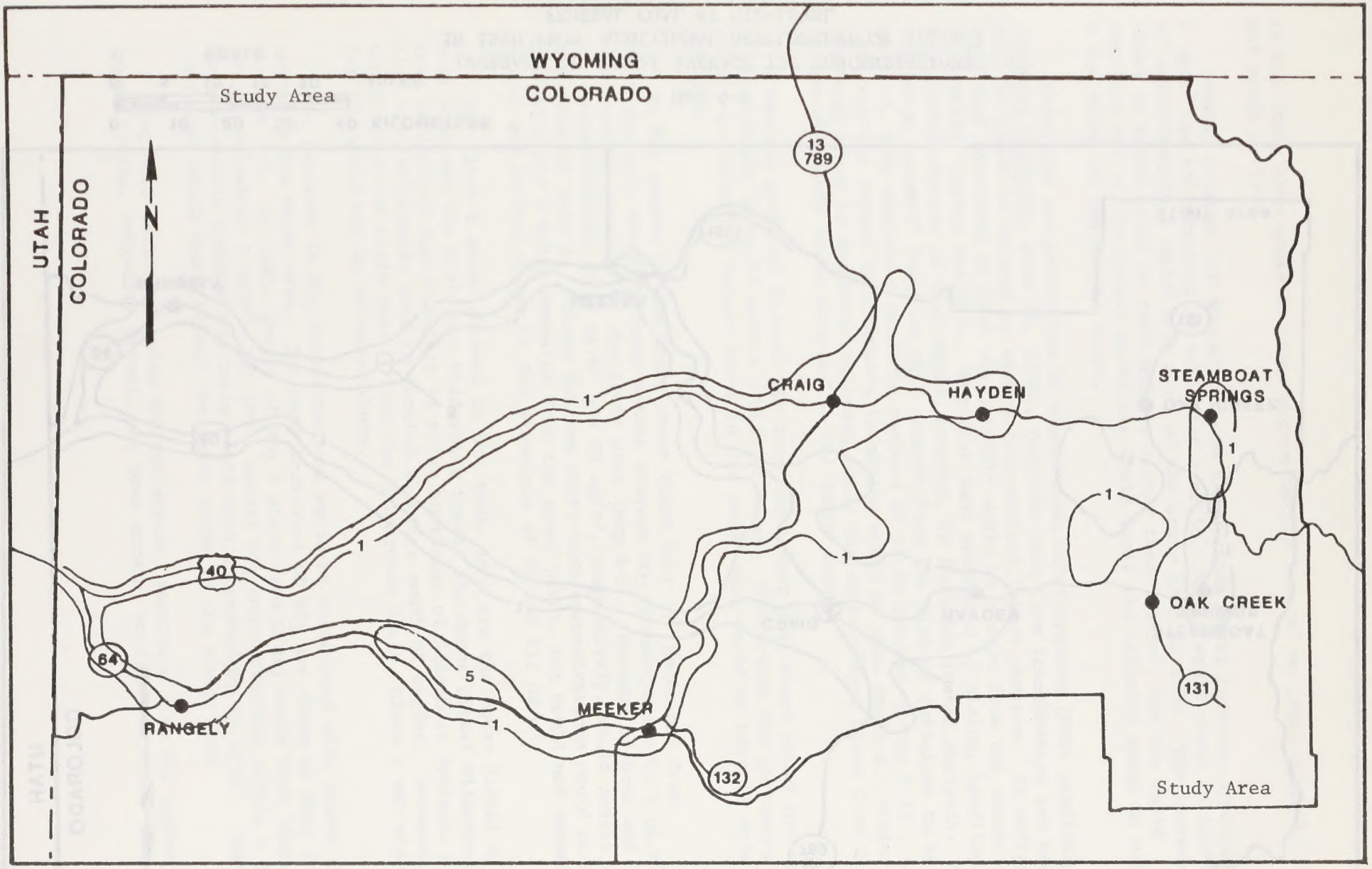
EMISSIONS FROM MAJOR POINT SOURCES IN THE STUDY AREA
FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL (TONS/YEAR)

Source	Pollutant	Emissions 1980	1985	1990
Hayden Power Plant				
Unit #1	Particulates	260	260	260
	SO_2	5,680	5,680	5,680
	NO_x	5,730	5,730	5,730
	CO	318	318	318
Unit #2	Particulates	388	388	388
	SO_2	8,480	8,480	8,480
	NO_x	8,551	8,551	8,551
	CO	475	475	475
Craig Power Plant				
Unit #1	Particulates	1,082	1,082	1,082
	SO_2	5,567	5,567	5,567
	NO_x	10,825	10,825	10,825
	CO	771	771	771
Unit #2	Particulates	1,082	1,082	1,082
	SO_2	5,567	5,567	5,567
	NO_x	10,825	10,825	10,825
	CO	771	771	771
Unit #3	Particulates	-	1,546	1,546
	SO_2	-	6,185	6,185
	NO_x	-	10,825	10,825
	CO	-	771	771
Asphaltic Concrete Rotary Drier (east of Craig)	Particulates	339	339	339
Amoco Petroleum Storage Tanks (12 miles south of Craig)	NMHC	398	398	398



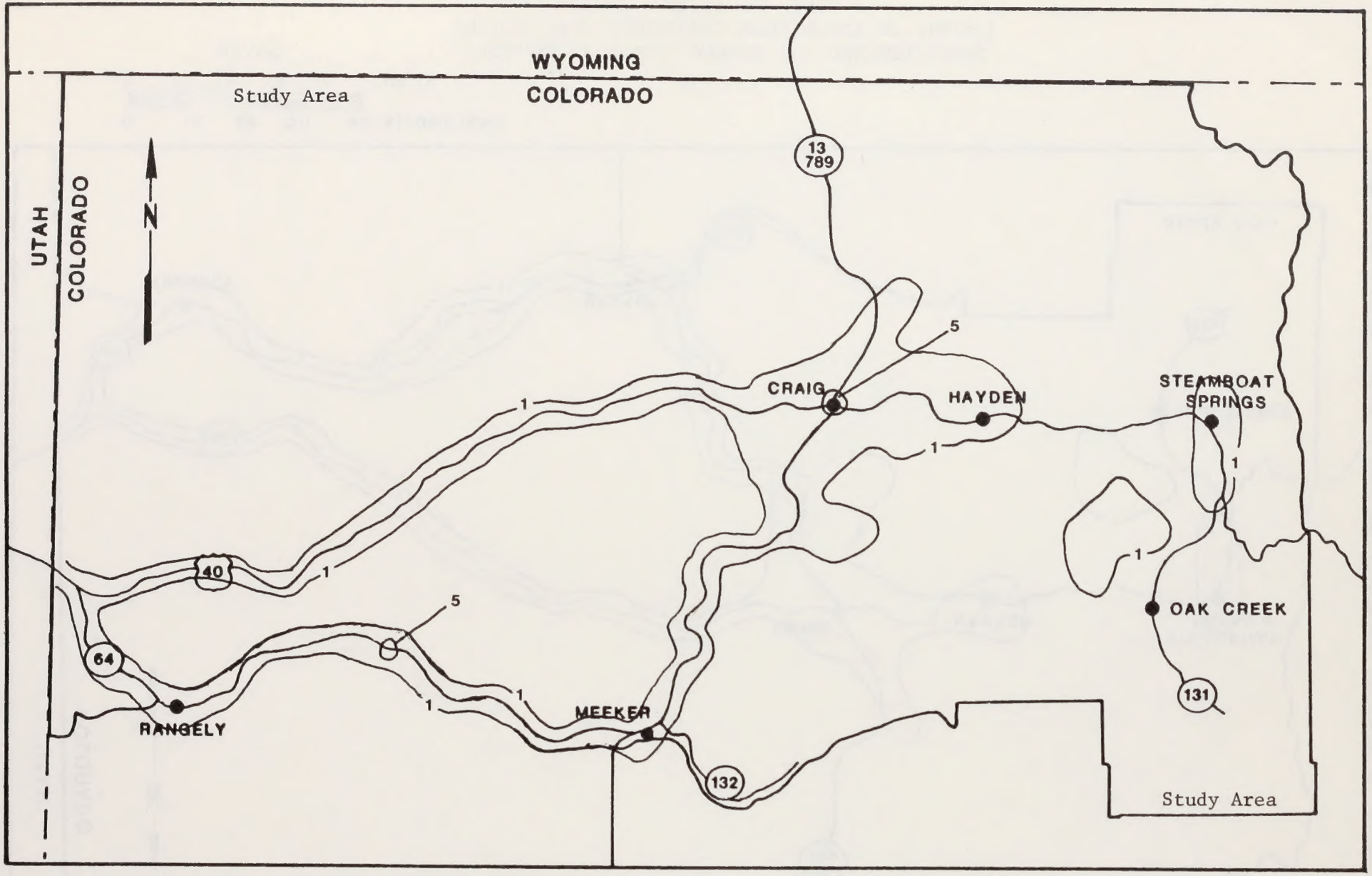
Map 4-2

INCREASE OF ANNUAL AVERAGE TSP CONCENTRATIONS
IN 1980 FROM ADDITIONAL DEVELOPMENT OF ($\mu g/m^3$)
FEDERAL COAL AT MID-LEVEL



Map 4-3

INCREASE OF ANNUAL AVERAGE TSP CONCENTRATIONS
IN 1985 FROM ADDITIONAL DEVELOPMENT OF ($\mu g/m^3$)
FEDERAL COAL AT MID-LEVEL



Map 4-4

INCREASE OF ANNUAL AVERAGE TSP CONCENTRATIONS
IN 1990 FROM ADDITIONAL DEVELOPMENT OF ($\mu g/m^3$)
FEDERAL COAL AT MID-LEVEL

in the study area would increase approximately 1 ug/m^3 by 1980, again by 1985, and again by 1990.

Annual average TSP concentrations along roads would increase approximately 1 ug/m^3 due to increases in vehicular traffic. Mines would cause an increase of approximately 1 ug/m^3 over much of the study area by 1990. TSP increases close to mines could be considerably higher than 1 ug/m^3, but the rapid settling out of the larger particles would limit the affected areas to within a few miles of individual mines.

Under the new prevention of significant deterioration (PSD) regulations (Federal Register, June 18, 1978), fugitive dust from transporting and hauling soil at mines is omitted or exempt from ambient impact reviews. In addition, road dust generated by haul road traffic would be exempt from the second tier air quality impact analysis. Fugitive dust generated by mining, handling, and transportation of coal would, however, be included in the analysis. By excluding "exempt" fugitive dust sources from the list of emissions to be modeled, mine emissions would be reduced 65 to 85 percent (Table 4-12), and the regional impact attributable to mining would be even smaller. Therefore, the coal mines in northwest Colorado would not cause either Class I or Class II PSD standards to be exceeded in the study area.

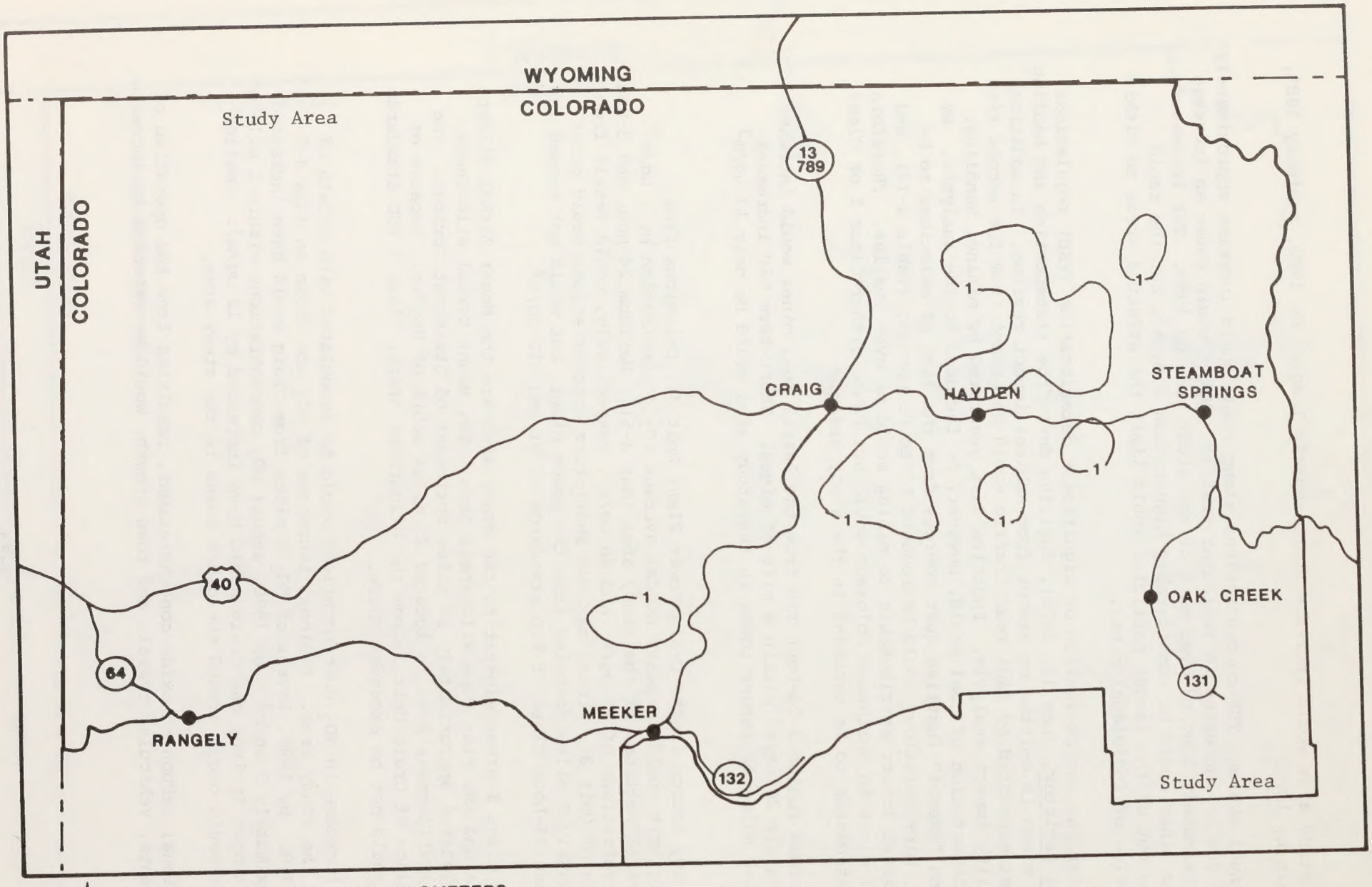
Maximum regional 24-hour TSP from the larger coal mines would increase approximately 70 ug/m^3 within a mile of mines. Short-term TSP increases within 1-2 miles of larger towns in the study area would be near 17 ug/m^3 by 1990.

An SO_2 source is the Craig Power Plant Unit 3. Emissions from the Craig unit would increase annual average SO_2 concentration by 1 ug/m^3 over several sections of the study area (Map 4-5). Maximum 24-hour and 3-hour SO_2 concentrations of 12 ug/m^3 and 98 ug/m^3, respectively, would result from operation of Unit 3. These maximum short-term concentrations would occur approximately 3 miles downwind from the power plant, but would not exceed the 3-hour and 24-hour Class II PSD standards of 91 and 512 ug/m^3.

The Class I areas closest to the study area are the Mount Zirkel Wilderness Area and the Flat Tops Wilderness Area. The Mount Zirkel Wilderness Area is located approximately 11 miles northeast of Steamboat Springs. The Flat Tops Wilderness Area is located 25 miles south of Hayden. Because of the distance of Craig Unit 3 from the Wilderness Areas, Class I PSD standards for SO_2 would not be exceeded there.

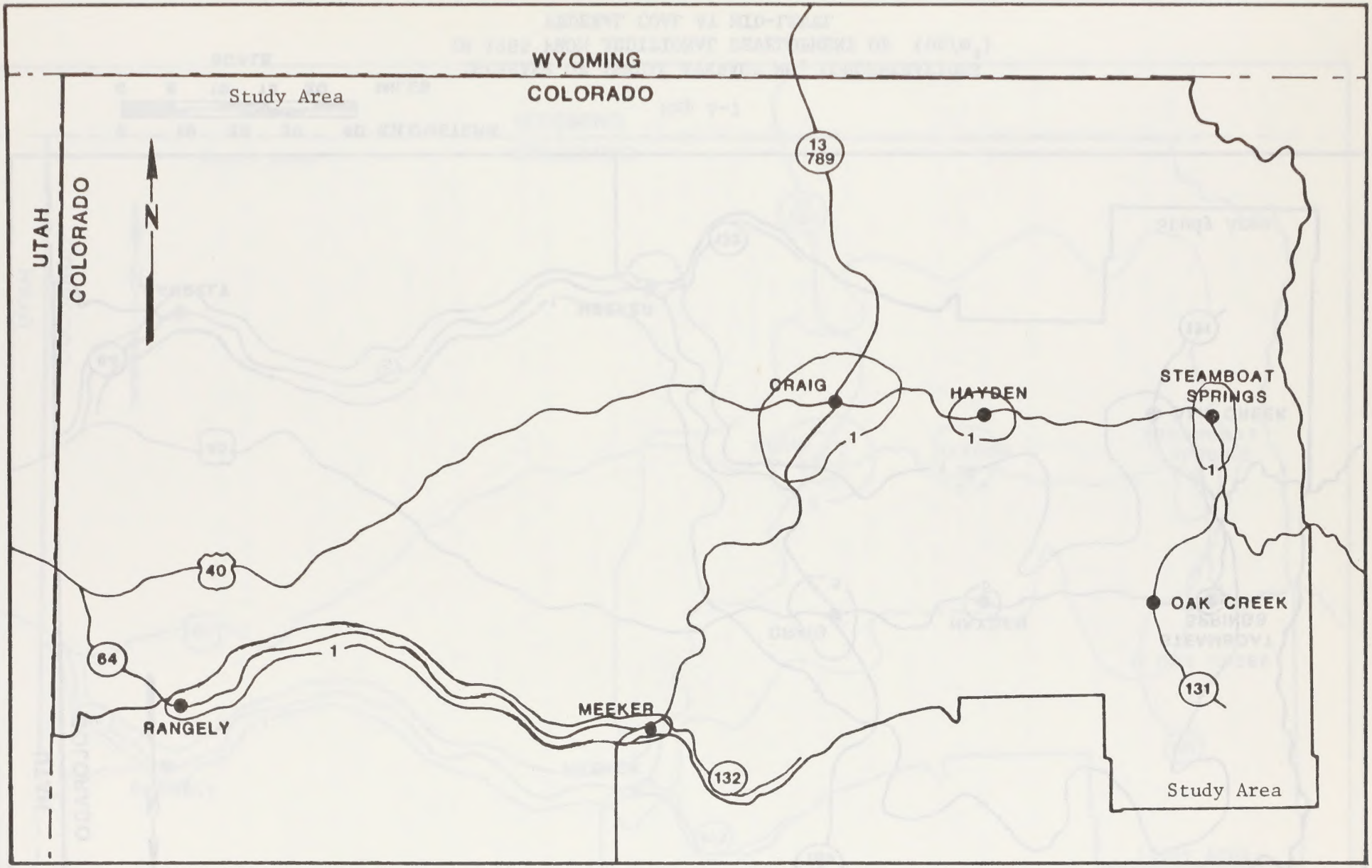
An increase in NO_2 concentrations would be associated with growth of towns in the study area. Regional increases of NO_2 are shown on Maps 4-6 through 4-8. By 1985, levels of NO_2 5 miles from Craig would have increased by approximately 5 ug/m^3. By 1990, annual NO_2 concentrations within 1 mile of both Steamboat Springs and Craig would have increased by 12 ug/m^3. Smaller increases would occur around the other towns in the study area.

Regional carbon monoxide concentrations, resulting from the operation of power plants, vehicular travel, and town growth, would be expected to increase



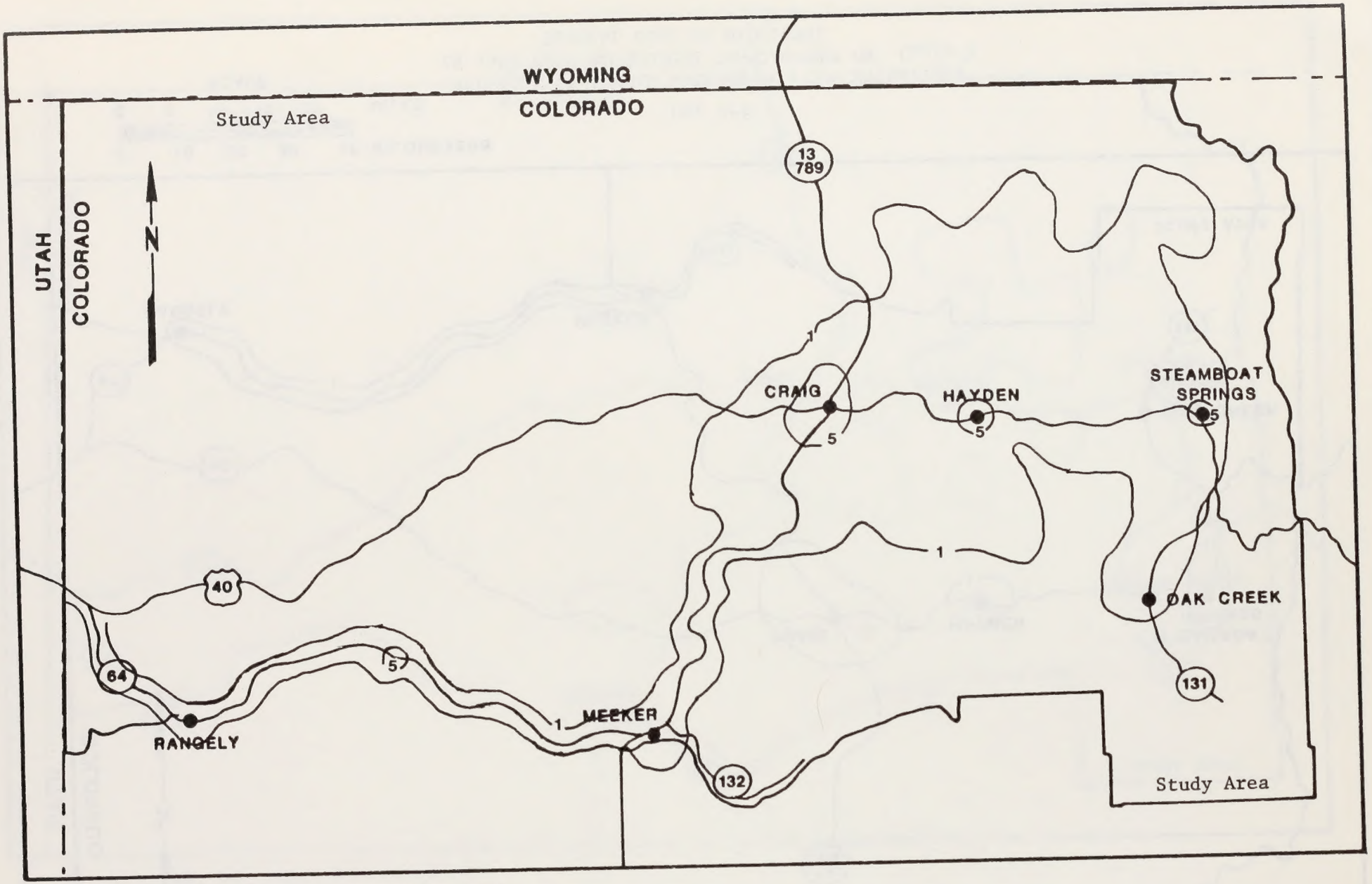
Map 4-5

INCREASE OF ANNUAL AVERAGE SO_2 CONCENTRATIONS
IN 1985 AND 1990 FROM ADDITIONAL DEVELOPMENT OF ($\mu g/m^3$)
FEDERAL COAL AT MID-LEVEL



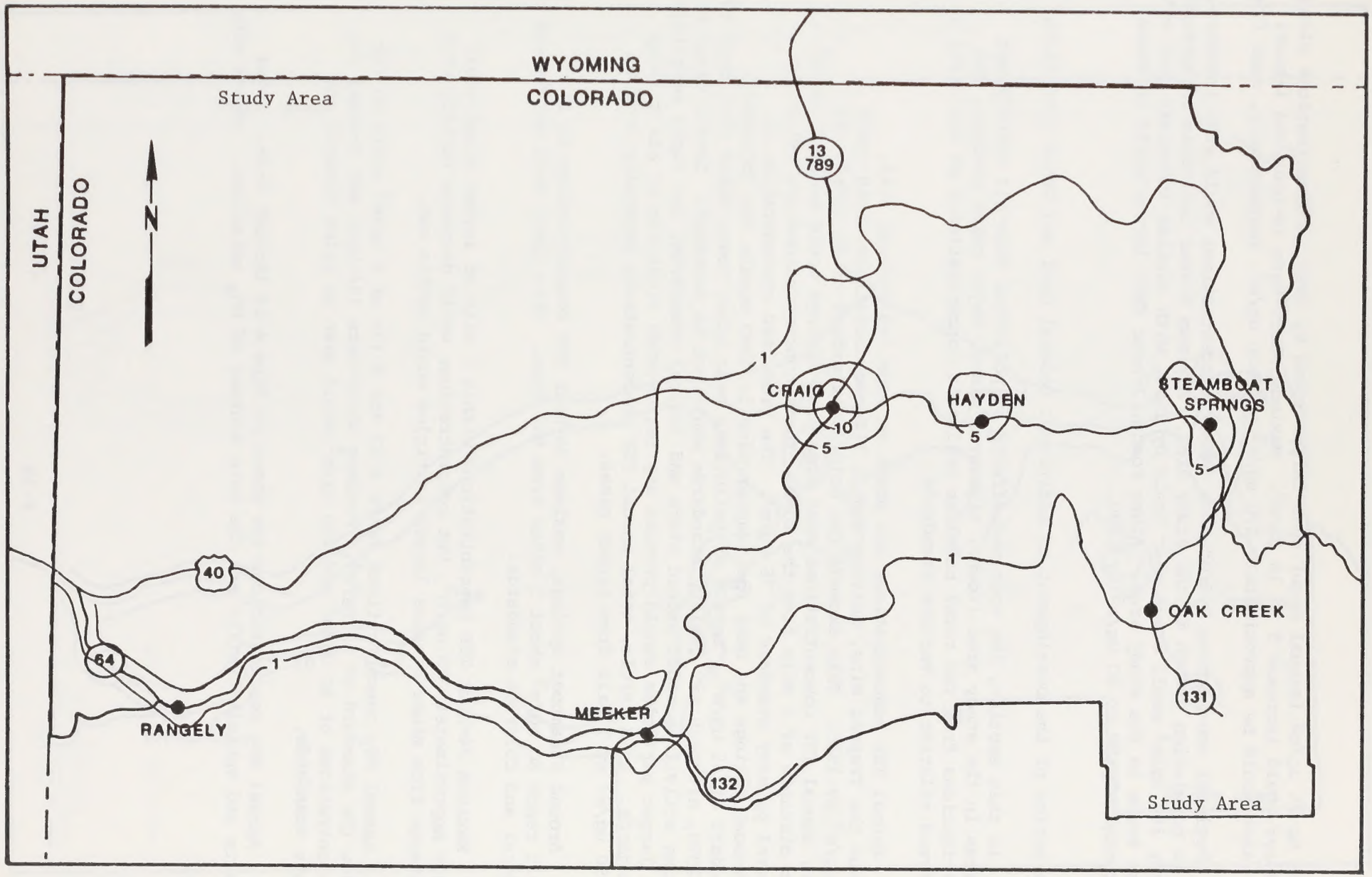
Map 4-6

INCREASE OF ANNUAL AVERAGE NO_2 CONCENTRATIONS
IN 1980 FROM ADDITIONAL DEVELOPMENT OF ($\mu g/m^3$)
FEDERAL COAL AT MID-LEVEL



Map 4-7

INCREASE OF ANNUAL AVERAGE NO_2 CONCENTRATIONS
IN 1985 FROM ADDITIONAL DEVELOPMENT OF ($\mu g/m^3$)
FEDERAL COAL AT MID-LEVEL



Map 4-8

INCREASE OF ANNUAL AVERAGE NO_2 CONCENTRATIONS
IN 1990 FROM ADDITIONAL DEVELOPMENT OF ($\mu g/m^3$)
FEDERAL COAL AT MID-LEVEL

by 25 to 85 ug/m^3 (annual mean) near larger towns by 1990. Concentrations along roadways would increase 5 to 10 ug/m^3. Maximum short-term (8-hour and 1-hour) increases would be approximately 370 ug/m^3 and 600 ug/m^3, respectively, near Craig.

Regional non-methane hydrocarbon (NMHC) concentrations would also increase, due to population growth in the study area. Maximum 3-hour increases of approximately 150 ug/m^3 would occur near Craig by 1990, with similar increases near other large towns in the study area. Along roads, 3-hour NMHC levels would increase approximately 50 to 60 ug/m^3 by 1990.

Interaction of the Development of Additional Federal Coal and Other Activities

In this section, the combined effects of pollution from all significant sources in the study area (towns, highways, mines, major point sources, and contributions from the rural baseline pollutant concentrations) at mid-level is analyzed relative to various standards.

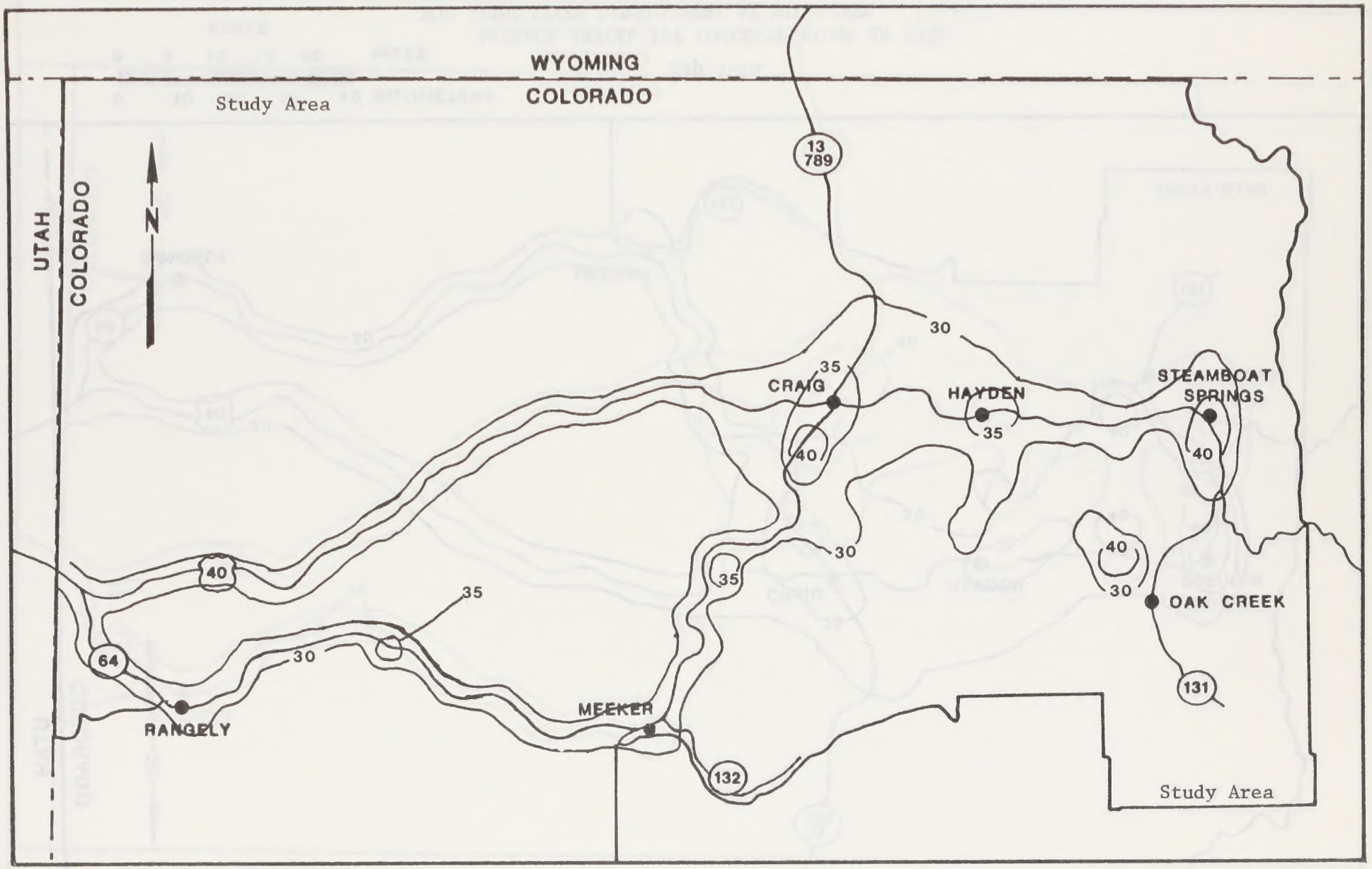
Annual TSP concentrations are shown on Maps 4-9 through 4-11. Around the Trapper mine, maximum annual TSP concentrations would reach 50 ug/m^3 by 1985. This exceeds the Colorado standard of 45 ug/m^3. By 1990, annual TSP concentrations near Steamboat Springs would reach 45 ug/m^3 at a distance of 1 mile from the town. These concentrations are below the federal primary standard of 75 ug/m^3. The predicted concentration at Steamboat Springs and near the Trapper mine in 1990 equals the Colorado standard of 45 ug/m^3. Levels of pollutants near other towns would rise from 1980 to 1990, although air quality standards would not be exceeded. Levels close to mining activities could exceed state and federal standards, but rapid settling of the larger particles should prevent any region-wide violation of air quality standards. As a result, total annual TSP concentrations generally drop to 40-50 ug/m^3 at 1 mile from larger mines.

Around Steamboat Springs, maximum 24-hour TSP concentrations in 1990 would reach 80 ug/m^3 about 2 miles from the town. This level does not exceed federal and Colorado standards.

Maximum 24-hour TSP concentrations within 1 mile of larger mines would reach approximately 70 ug/m^3, but concentrations would decrease rapidly with distance from mines because larger particles would settle out.

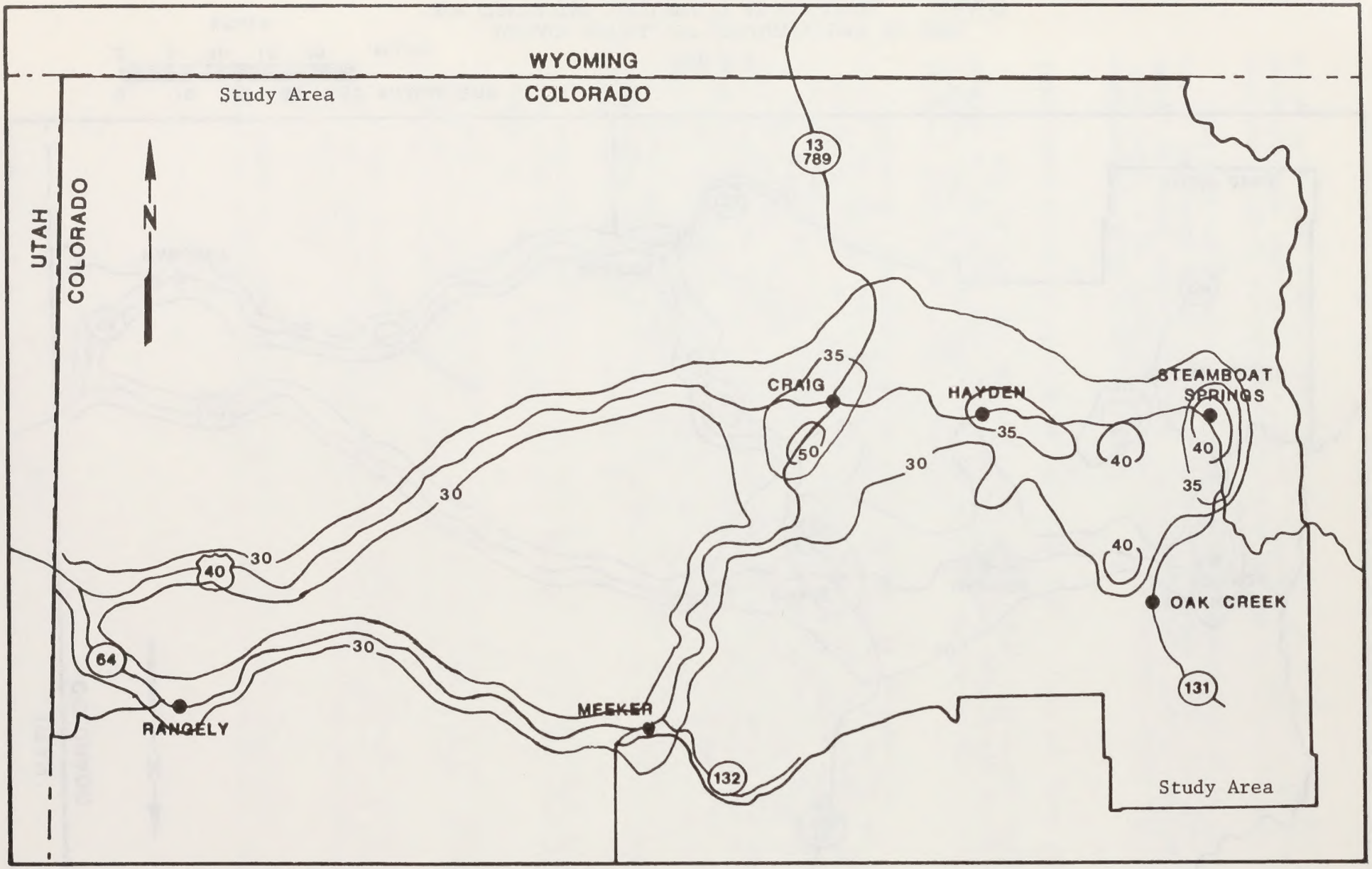
Annual SO_2 concentrations (Maps 4-12 and 4-13) of 5 ug/m^3 would be far below the standard of 80 ug/m^3. Maximum short-term (24-hour and 3-hour) SO_2 concentrations of 40 ug/m^3 and 250 ug/m^3 would also be below federal and state standards.

Annual NO_2 concentrations are shown on Maps 4-14 through 4-16. Power plants and vehicle traffic are the main sources of NO_x emissions. Region-wide



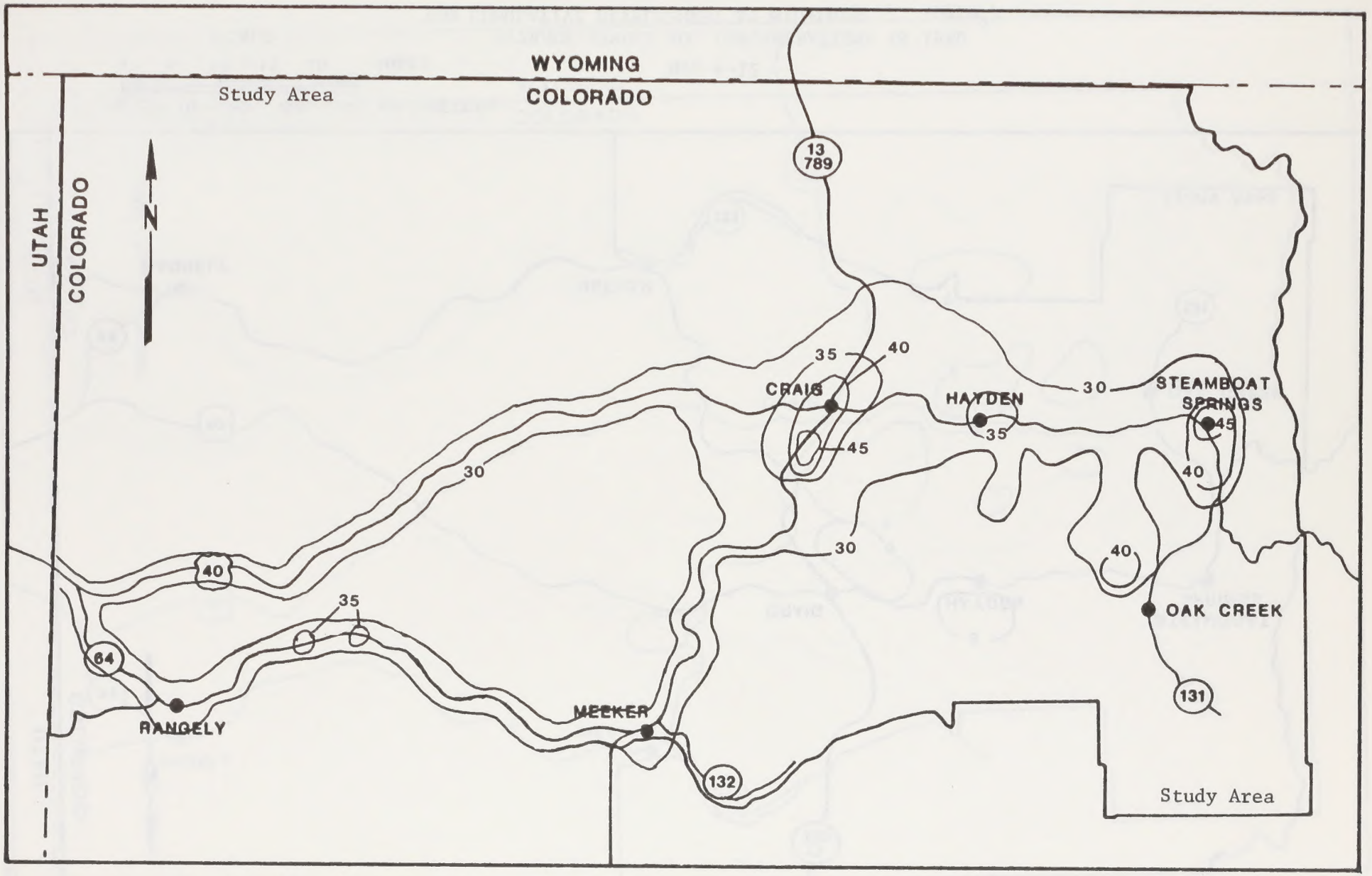
Map 4-9

AVERAGE ANNUAL TSP CONCENTRATIONS IN 1980
FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL ($\mu g/m^3$)



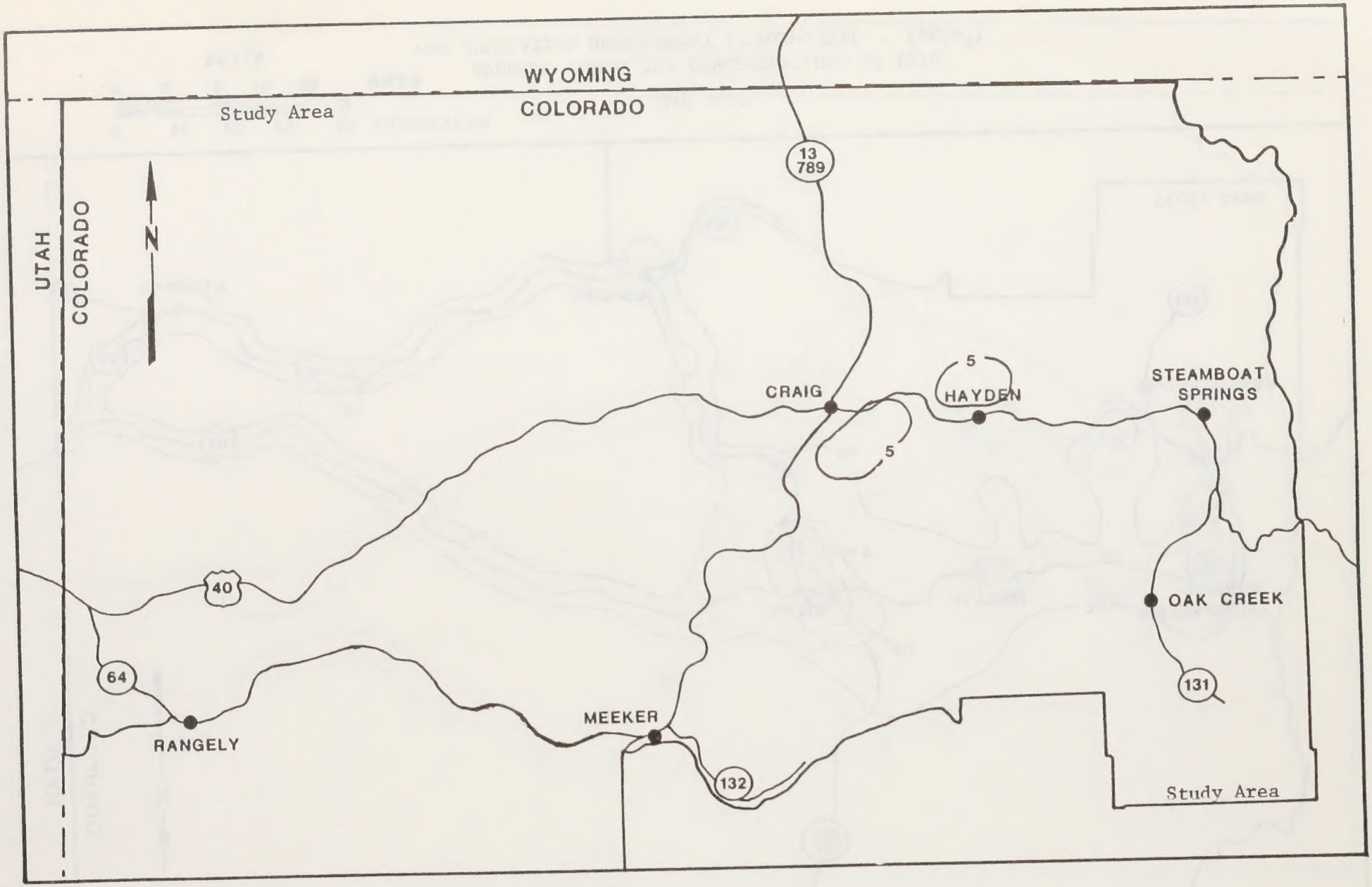
Map 4-10

AVERAGE ANNUAL TSP CONCENTRATIONS IN 1985
FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL ($\mu g/m^3$)



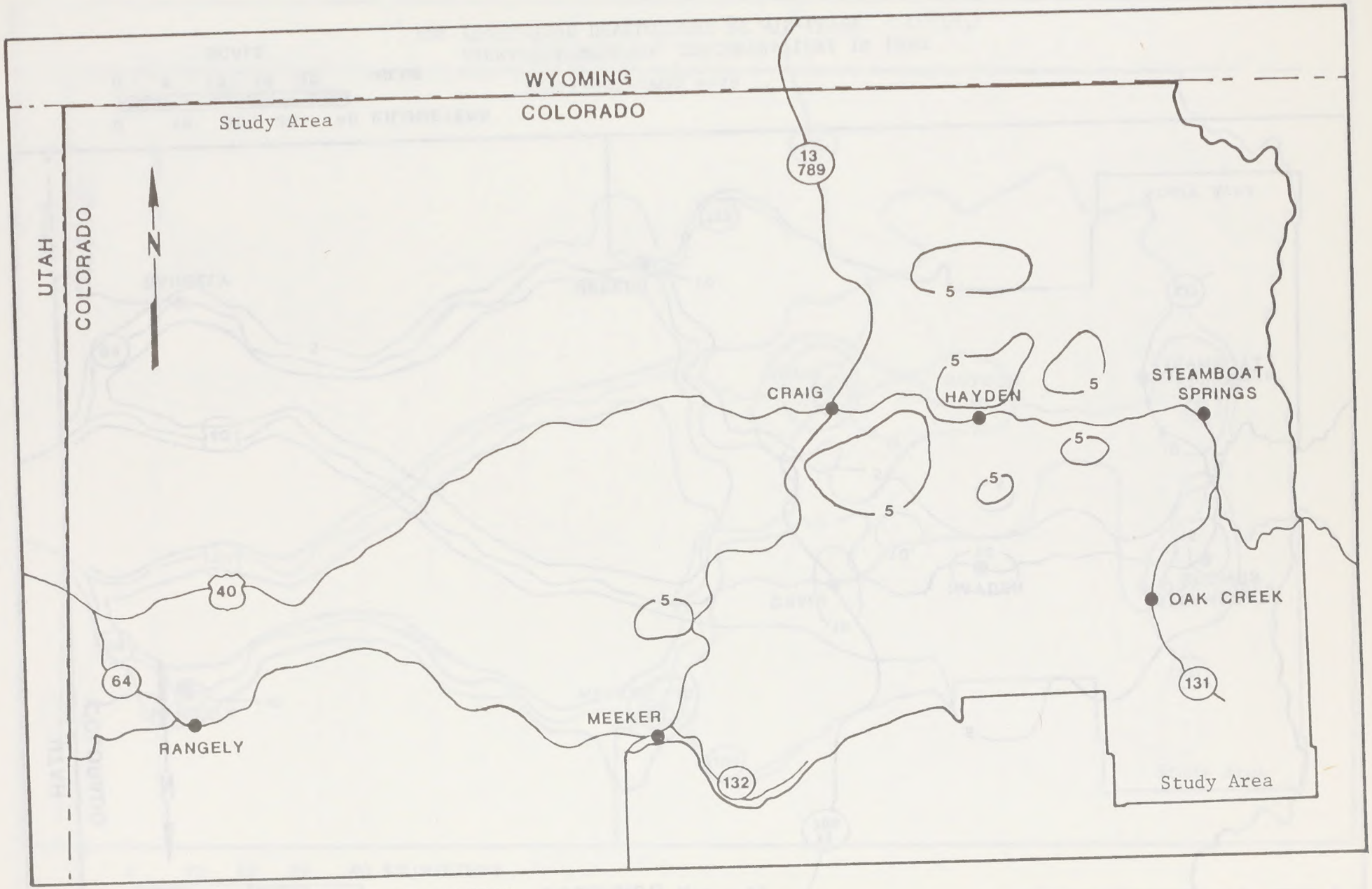
Map 4-11

AVERAGE ANNUAL TSP CONCENTRATIONS IN 1990
FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL ($\mu g/m^3$)



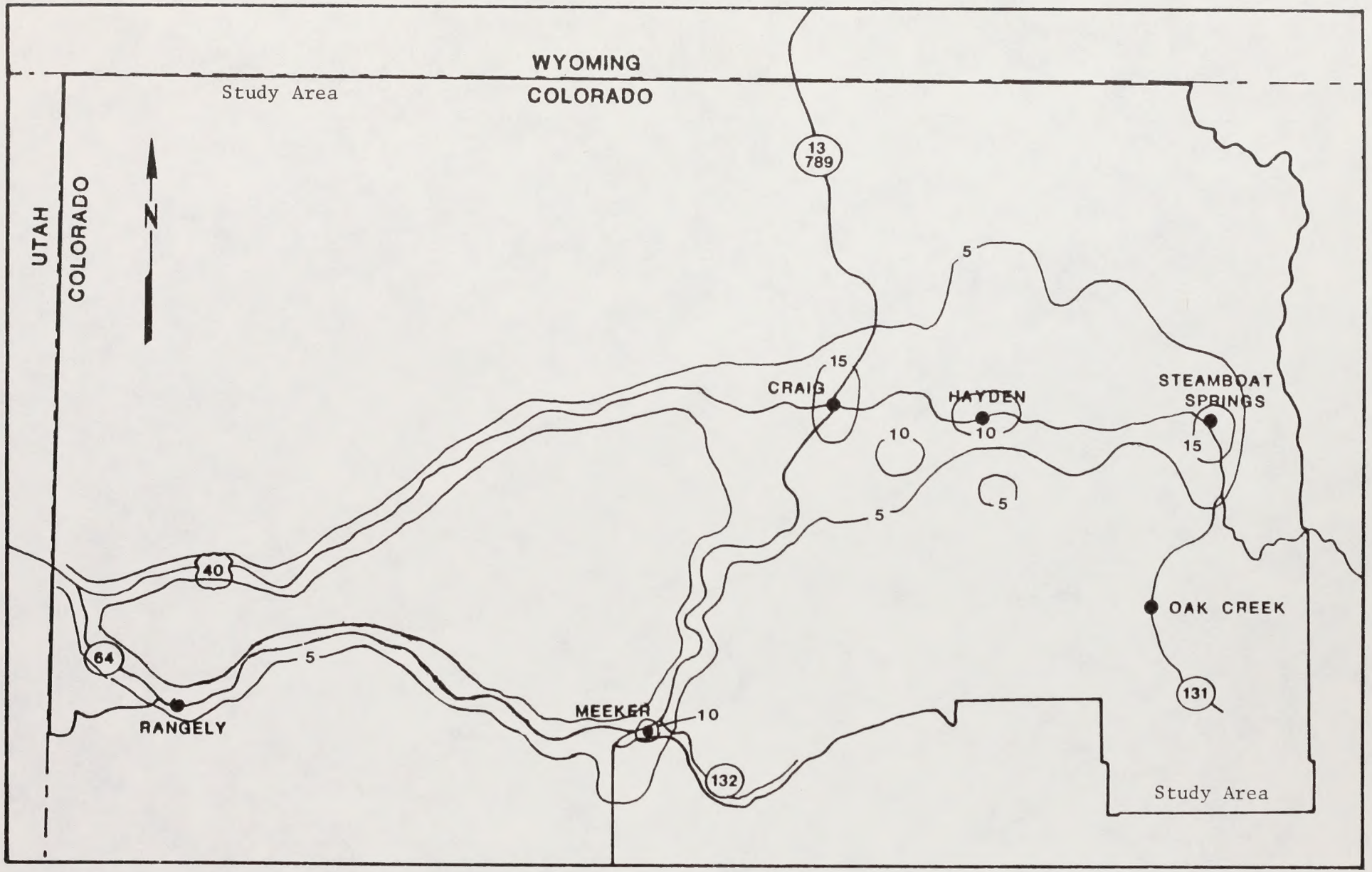
Map 4-12

AVERAGE ANNUAL SO_2 CONCENTRATIONS IN 1980
FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL ($\mu g/m^3$)



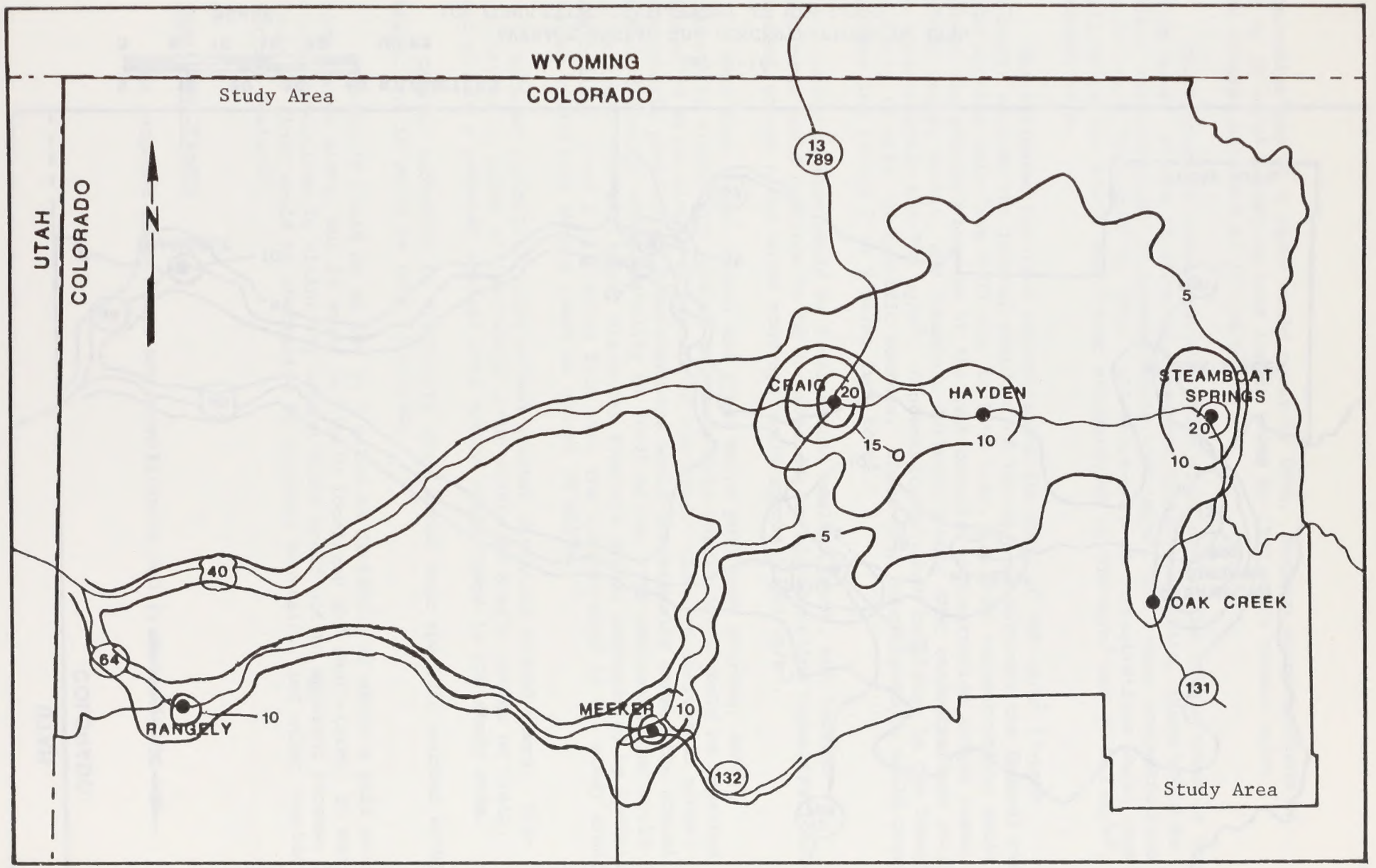
Map 4-13

AVERAGE ANNUAL SO_2 CONCENTRATIONS IN 1985 AND 1990
FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL ($\mu g/m^3$)



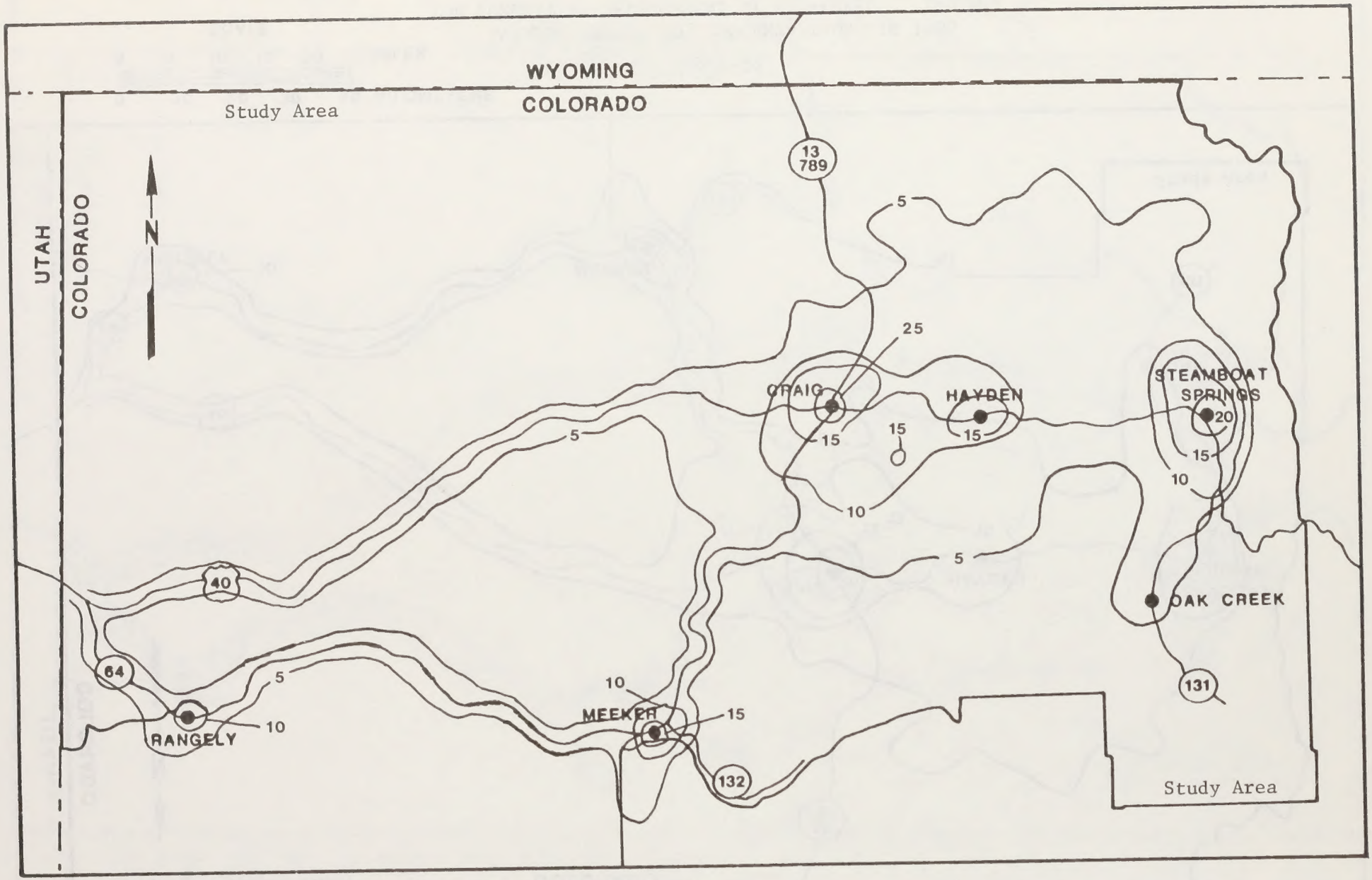
Map 4-14

AVERAGE ANNUAL NO_2 CONCENTRATIONS IN 1980
FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL ($\mu g/m^3$)



Map 4-15

AVERAGE ANNUAL NO_2 CONCENTRATIONS IN 1985
FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL ($\mu g/m^3$)



Map 4-16

AVERAGE ANNUAL NO_2 CONCENTRATIONS IN 1990
FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL ($\mu g/m^3$)

concentrations of 5 ug/m^3 would occur by 1990. Maximum concentrations of 15 to 25 ug/m^3 occurring near larger towns by 1990 would remain below the federal standard of 100 ug/m^3.

The highest CO concentrations would occur around the larger towns in the study area. Within 1½ miles of Steamboat Springs and Craig, there would be 8-hour concentrations of approximately 4500 ug/m^3, and 1-hour concentrations would reach 7400 ug/m^3 by 1990. All short-term CO concentrations would remain well below the 8-hour and 1-hour standards of 10,000 ug/m^3 and 40,000 ug/m^3, respectively.

The estimated baseline concentration for NMHC of 446 ug/m^3 (3-hour average) exceeds the federal standard of 160 ug/m^3. Although the federal standard applies only from 6:00 a.m. to 9:00 a.m., all NMHC concentrations would exceed the standard because of the high baseline concentration around towns. Around Craig, Meeker, and Steamboat Springs, 3-hour NMHC concentrations would be approximately 600-700 ug/m^3. Concentrations would be higher in the immediate vicinity (½ mile) of specific sources. These high concentrations would decrease to baseline levels 7 to 9 miles from towns.

Concentrations would be lower around smaller towns, but federal standards would continue to be exceeded due to high baseline concentrations. Concentrations along major roadways would approach 500 ug/m^3.

Away from towns, mines, and other major pollutant sources, annual horizontal visibility related to atmospheric particulates would be expected to exceed 48 miles almost 50 percent of the time. Close to individual mines, atmospheric particulate concentrations would occasionally exceed the annual standard locally with visibility of 20-25 miles. TSP concentrations would be markedly less even short distances from all mines, accompanied by increased visibility. From 1 to 2 miles from even the largest mine in the study area, annual visibility should reach or exceed 35 miles.

Reduced visibility would extend greater distances around towns. Visibility of 43 miles or less would occur within an 8-mile radius of Craig, and within a somewhat smaller area around other towns in the study area.

Greater reduction in visibility could occur near specific sources within towns, but it would be very localized.

Visibility could be as low as 7 miles at distances of about a half mile from larger mines, but it would be highly localized and short-term. In many cases, reductions in visibility around miles would not be apparent because lines of sight would be obstructed by canyons, mountains, and other complex terrain features.

Resultant Climate

The proposed mines would not significantly modify the climate and

meteorology of the study area.

Temporary loss of vegetation in mining areas may slightly decrease the amount of moisture locally available for the formation of thunderstorms during the late spring and early summer. However, the exposed soil would enhance convective heating, which contributes significantly to thunderstorm formation. Any increase of thunderstorms caused by the lack of vegetation would be extremely localized.

The redistribution of soils and other materials at the mines, railroad, and transmission lines in the study area could cause small changes in the local climate. The modification of surface contours and albedo could result in local changes in wind speeds and direction, temperatures, and relative humidity.

Soils in the study area would be most significantly affected by surface disturbance during overburden removal to reach the coal beds and construction of ancillary facilities and housing. Estimates are that cumulative mid-level land disturbance from production of coal and related development would occur on 7,900 acres during 1978-80, 11,810 acres during 1981-85, and 9,060 acres during 1986-90. Total disturbance would be 28,770 acres by 1990 (Table 1-6). That portion disturbed by additional development of federal coal at mid-level would be 1,610 acres during 1978-80, 4,345 acres during 1981-85, and 3,455 acres during 1986-90. Total disturbance from additional development of federal coal at mid-level would be 9,410 acres (Tables 1-6 and 1-7).

Surface mining disturbance would involve the removal of large amounts of soil, with major impacts being loss of soil, loss of natural soils integrity, and temporary disruption of soil productivity. The disturbance from surface mining would be 3,280 acres from 1978-80, 7,310 acres from 1981-85, and 7,330 acres from 1986-90, totaling 17,920. Additional federal coal at mid-level would account for 470 acres from 1978-80, 2,030 acres from 1981-85, and 2,500 acres from 1986-90, totaling 5,000 acres.

Loss of soil would result from wind and water action on the variety of soil textures exposed during removal, stockpiling, or redistribution. Due to the variable nature of wind velocity, the erosive force could detach the finer soil fraction and suspend those soil particles in the air, adversely affecting air quality and increasing soil loss. Additionally, water movement, accelerated by loss of vegetative cover, would remove exposed soil during high intensity storms, possibly forming gullies. Soil loss by water is assumed to be limited to mine sites, as regulations 30 CFR 715.17(a) and 717.17(a) require all surface drainage from areas disturbed by coal mining to pass through sedimentation ponds (see Chapter 3, Water Resources, Interception and Diversion of Runoff). However, on-site soil loss is to some extent unavoidable and could hamper reclamation and reduce soil productivity by erosion of nutrient rich topsoils from reclaimed areas.

Any soil material from sediment ponds that is redistributed will be a mixture of all soils from a particular mined area drainage, generally firmer in texture, and may not reflect the higher quality of the original topsoil. All areas surface mined at mid-level would be susceptible to mine site erosion, resulting in soil mixing. Due to the unpredictable nature of wind and water the magnitude of on-site soil losses and reduction in soil productivity cannot be calculated, but they should be minimal because OSM regulations (715.16(a) and 715.16(b)) stipulate that topsoil that has been removed and stockpiled be protected from wind and water erosion by revegetation.

Loss of natural soil integrity and creation of new soil complexes would result from all surface mining disturbance, altering naturally developed soil horizons, structure, permeability, inflitration, parent material, and soil micro-climates established over geologic time. Significant mixing of soil horizons would only result when soils have thin A horizons of less than 6 inches. As provided by the federal regulations, the A horizon would be mixed and diluted with the underlying horizon (B or C), to total 6 inches, to obtain a sufficient amount of topsoil to eventually become an adequate surface horizon. Such mixing would result in dilution of any organic matter or nutrient rich A horizon material and possible textural mixing, which could affect soil productivity for several years. Presently, detailed data is not available to determine amount of mixing of thin A horizons.

As mitigated by federal regulations (30 CFR 700), soil productivity would be temporarily disrupted between initial disturbance and the revegetation stage when disturbed areas would be restored and capable of supporting post-mining land use. Short-term reduction in soil productivity is a direct result of disturbing and altering the natural soil, with the short-term loss of vegetation depending upon reclamation success. The impacts of short-term loss of soil productivity at mid-level are indicated elsewhere in this chapter (see Vegetation and Wildlife sections for significance of forage and browse lost).

In addition to soil disturbed by surface mining, soil would be permanently disturbed from ancillary developments, including railroads, roads, surface and underground mine facilities and new housing developments. Cumulative mid-level permanent surface disturbance from related ancillary and housing development would be 2,740 acres from 1978-80, 4,500 acres from 1981-85, and 1,730 acres from 1986-90. Total disturbance of this development would be 8,970 acres. Permanent disturbance related to additional development of federal coal at mid-level would be 1,140 acres from 1978-80, 2,315 acres from 1981-85, and 955 acres from 1986-90, totaling 4,410 acres. All of this disturbance would result in permanent loss of productive soil (Table 1-4 and 1-6 contain itemized disturbance figures).

New housing developments would probably occur close to creeks and rivers, increasing sediment loads (see Water Resources and Aquatic Biology). Loss of natural soil and creation of new soil complexes would take place on all the areas disturbed. All soil surface permanently lost would mean loss of soil productivity with respect to premining land use and condition (see Vegetation and Wildlife). As population increases with coal development, higher recreational demands such as off-road vehicle use would cause soil compaction in localized areas of use and increase soil loss (see Recreation). Soil loss from increased off-road vehicle use as it relates to coal development in this study area is not quantifiable.

Soil disturbance would occur around areas of coal development (southwest Routt County, southeast Moffat County, and the area northeast of Meeker) and areas of population growth (Meeker, Craig, Hayden,

and Steamboat Springs). Soils affected in the study area are indicated on Map 1-1 (Appendix C), location of mines for mid-level on Foldout 8, Appendix B, NWCCRES, General Soil Map. Descriptions of soil associations including their characteristics and reclamation potentials appear in Table 2-21. The soil associations expected to be affected at mid-level coal development and estimated surface coverage are #59 (50 percent), #62 (30 percent), #21 (15 percent), and #35 (5 percent).

Soil association #59, a Mollisol, is a good source of topsoil due to the good quality loam surface textures developed under a 15-20 inch precipitation zone and a mountain shrub vegetative type, which is a high organic matter contributor. In a portion of the 50 percent of the mid-level coal development area covered by soil association #59, steep slopes occur, prohibiting topsoil removal or requiring slope stabilizing techniques such as mulching if the landscape is returned to the original steep topography. Soil erosion would be the direct result of excessive slopes.

The finer clay fraction of soil association #21, an Aridisol, and #62, a Mollisol, (totaling 45 percent of mid-level coal development area), could present erosion problems during topsoil removal, storage, and redistribution. Clayey textures are highly susceptible to water and wind erosion. Clayey soils have an inability to absorb water rapidly during high intensity storms. This characteristic increases the volume of surface runoff and the rapidity of flow over the land surface. Soil particles are more easily dislocated by this flow as well as being more susceptible to wind action. To avoid excessive erosion, the amount of exposed bare soil during revegetation and topsoil removal must be limited as well as establishing a quick, protective, vegetative cover on stockpiles and replaced topsoil. Other undesirable characteristics of clayey textures are ease of compaction by heavy equipment and lack of ability to hold soil moisture, diminishing the amount available to plants. Overall, soil associations #21 and #62 have a good potential for reclamation, providing all precautions are taken to overcome undesirable effects of clayey textures.

Soil association #35, an Entisol, (totaling 5 percent of mid-level coal development area), has a good potential for reclamation, except for its limited capacity to retain moisture during June and July. During this period, retention of moisture by soils is important to survival of vegetation.

Overall the reclamation potential in the study area is good, but due to the broad soil mapping units, mines could easily be developed on inclusions rather than on the major soil components. To actually quantify impacts in any specific coal development area, a detailed soil survey, as required by OSM regulations, is needed to complement a cumulative soil association analysis. This would be necessary to further identify soil types, distribution, physical and chemical characteristics, inclusions, and reclamation potentials. A detailed soil survey would provide the necessary premining guide for identifying undisturbed soil characteristics to aid in reclamation.

Development of coal in the study area would result in both temporary and permanent impacts to vegetation. Where the vegetation would be removed from an area which would be reclaimed, such as a surface mine, the loss would be considered temporary. Where vegetation would be removed for developments of a long-term nature such as shop and office buildings for a mine or housing developments, the loss would be considered permanent.

Development of coal resources at the mid-level would cause the temporary disturbance of 5,160 acres of vegetation by 1980, an additional 7,310 acres by 1985, and an additional 7,330 acres by 1990, totaling 19,800 acres by 1990. Of this acreage, development of additional federal coal would temporarily disturb 470 acres by 1980, an additional 2,030 acres by 1985, and an additional 2,500 acres by 1990, totaling 5,000 acres by 1990.

The process of revegetation of the above disturbed acreage would be expected to have begun on 200 acres by 1980, an additional 5,160 acres by 1985, and an additional 7,310 acres by 1990, totaling 12,670 acres by 1990. Of the acreage, revegetation is expected to have begun on 100 acres of lands disturbed by additional federal coal by 1980, an additional 470 acres by 1985, and an additional 2,030 acres by 1990, totaling 2,600 acres by 1990.

Development of coal resources along with ancillary facilities and housing would cause the permanent loss of 2,740 acres of vegetation by 1980, an additional 4,500 acres by 1985, and an additional 1,730 acres by 1990 for a total permanent loss of 8,970 acres by 1990. Development of additional federal coal would account for 1,140 acres of the permanent loss of vegetation by 1980, an additional 2,315 acres by 1985, and an additional 955 acres by 1990, totaling 4,410 acres by 1990. These acreages and types of vegetation disturbance can be found in Tables 1-4 and 1-6.

Disturbance to vegetation would be expected to involve the following vegetative types: sagebrush, 43 percent (0.55 percent of this type in the total study area (northwest Colorado)); mountain shrub, 25 percent (1.08 percent of this type in the study area); aspen, 9 percent (1.48 percent of this type in the study area); creek bottom, 6 percent (7.6 percent of this type in the study area); cropland, 15 percent (2.4 percent of this type in the study area); pinyon-juniper, 2 percent (0.08 percent of this type in the study area).

A direct result from the removal of vegetation would be loss of production for grazing livestock and wildlife. Each vegetative type is calculated as having a certain number of acres per animal unit month (AUM). The sagebrush type has 8 acres per AUM, mountain shrub type 6 acres per AUM, aspen woodlands type 3 acres per AUM, and creek bottom type 1 acre per AUM.

Temporary disturbance of vegetation would result in a loss of vegetative production. A period of approximately four years following the time of disturbance would occur before reclamation would have progressed sufficiently to permit grazing. The temporary disturbance to vegetation which would occur by 1980 would result in an eventual loss of 3,830 AUMs, the additional disturbance to vegetation occurring by 1985 would result in a loss of 5,420 AUMs, and the disturbance to vegetation by 1990 would result in 5,440 AUMs lost for a total of 14,690 AUMs lost. Of this, development of additional federal coal would account for 350 AUMs by 1980, 1,510 AUMs by 1985, and 1,860 AUMs by 1990, totaling 3,720 AUMs lost (Table 4-16).

The permanent loss of production resulting from the permanent loss of vegetation would be 510 AUMs per year by 1980, 1,340 AUMs per year by 1985, and 1,660 AUMs per year by 1990. Development of additional federal coal would account for 210 AUMs per year of this loss by 1980, 640 AUMs per year by 1985, and 820 AUMs per year by 1990 (Table 4-16).

TABLE 4-16

CUMULATIVE LOSS OF VEGETATION PRODUCTION (AUMs)
RESULTING FROM MID-LEVEL DEVELOPMENT

Production	1980	1985	1990
Temporary (all coal-related development)	3,830	9,250	14,690
Permanent per year (all coal-related development)	510	1,340	1,660
Temporary (additional development of federal coal)	350	1,860	3,720
Permanent per year (additional development of federal coal)	210	640	820

Loss of production for livestock and wildlife would mean fewer numbers of each in the areas of coal development - southwest Routt County, southeast Moffat County, and the area northeast of Meeker in Rio Blanco County. This loss of production could be significant to livestock producers whose operations are affected. The significance to an individual operator would be proportional to the area of his operation lost (see Domestic Fauna). The impact of lost production to wildlife would not be significant compared to the total wildlife populations of the study area (see Wildlife).

Total removal of native vegetation from an area would result in additional impacts on the vegetative ecosystem. There would be loss of a diverse vegetation capable of withstanding climatic extremes and utilizing precipitation and sunlight throughout the growing season. There would also be a loss of the present vegetative successional stage. The present vegetative successional stage has been reached slowly as a variety of plants suited to a particular site have become established. When a site is revegetated, a relatively small number of species would be used, those that can establish themselves in an open area such as the grasses. This simpler vegetation would be more susceptible to climatic extremes and diseases. Transplanting of trees and shrubs on a site could speed the establishment of a more diverse vegetative ecosystem.

Loss of soil productivity (see Soils) would affect the time needed to reestablish vegetative ecosystems. Twenty to 50 years may be required for vegetative ecosystems to be returned to their previous stage of successional development on strip mined lands, depending on climatic conditions and success of reclamation. Current reclamation practices have not been in use long enough to determine whether a significant number of native plant species can be established on reshaped topsoil spoils.

With the loss of vegetation on the site, the probability of increasing livestock and wildlife numbers on adjacent sites is high, with probable over utilization of adjacent sites. Reclamation could reestablish forage after 4 years, however (see Domestic Fauna).

Changes in ground water flows which may result from mining (see Water Resources) would effect vegetation. Increases near the surface would increase vigor and density of vegetation while a loss may have the opposite effect. The location of these impacts attributable to changes in ground water cannot be predicted but would be limited to the area of coal development and are not expected to be widespread or significant.

Changes in surface water flows would be limited to the area of coal development and not expected to be significant to vegetation.

Threatened and Endangered Species

Vegetation has not been studied in sufficient depth to determine locations of threatened or endangered species within the study area.

Wildlife

Impacts from mid-level coal development and ancillary activities would have adverse effects on wildlife habitat and species in the study area. All of the wildlife species in the area would be impacted from the permanent loss of habitat resulting from new roads, power plants, railroads, and construction of housing to accommodate population growth. There would be 2,740 acres of habitat permanently removed by 1980, 7,240 acres by 1985, and 8,970 acres by 1990. In addition to the permanently lost acreage, there would be a temporary disturbance of 5,160 acres by 1980, 12,470 acres by 1985, and 19,800 acres by 1990 from powerline construction and surface mining.

Portions of the area would be revegetated, but by 1990 none of the areas would be considered at carrying capacities comparable to existing wildlife habitat communities. It would take 30 to 70 years to establish comparable wildlife communities since the majority of plant species used to revegetate the mid-level disturbed areas would be a variety of grasses, forbs, shrubs, and trees with a small percentage returned to a floral composition similar to what presently exists in mountain shrub communities. By contrast, it would take less time, 20 to 50 years, to establish vegetation for domestic animals because wildlife use more browse species, which take longer to establish, and wildlife are not as easy to manipulate as domestic animals. Every species of terrestrial fauna in the study area, listed in Appendix D (NWCCRES), would be affected by loss of habitat. The degree of impact would depend on the adaptability of the species involved and their mobility. Because of a lack of species density and composition data for the majority of wildlife species it is impossible to adequately estimate the reduction in carrying capacity for most non-game species that would result from mid-level coal development. Most species fit into relatively narrow habitat niches. Those species closely associated with sagebrush and mountain shrub habitat types would be the most severely impacted by coal development while species associated with grasslands would be adversely impacted during mining but beneficially impacted after revegetation (Appendix D, NWCCRES).

Permanently lost habitat would have the most significant impact on game species such as elk, mule deer, antelope, and sage grouse. Most of the loss would accrue to the sagebrush, mountain shrub, and aspen habitat types, which now constitute deer and elk winter range. This loss would be 6,100 acres, only 0.22 percent of this habitat in the entire study area. Permanent loss of habitat would probably result in the loss of some wildlife. This loss would not be significant; it would be small compared to the number of animals presently lost each year to car-animal collisions between Craig and the Wyoming border. Elk and antelope would be displaced to surrounding areas. There would be a loss of some mule deer,

since the population is near carrying capacity on critical habitat sites. Some sage grouse would also be lost, since the loss of habitat would result in destruction of strutting grounds, which are critical for production. The estimates in Table 4-17 do not represent total loss of animals up to 1990 but only loss of sufficient habitat to support these animals.

The reason for the difference in permanent habitat lost is that the entire study area is mule deer habitat but only portions of the area are habitat for elk, antelope and sage grouse. Of the total acreage of deer habitat permanently lost, 30 percent is critical habitat, which would result in a direct loss of 27 deer by 1980, 70 deer by 1985, and 88 deer by 1990. This loss is due to the surrounding area not being capable of absorbing the displaced deer.

TABLE 4-17

PERMANENT LOSS OF HABITAT AND DISPLACEMENT OF INDIVIDUALS FOR GAME SPECIES

Species	Numbers of individuals displaced			Acres of habitat permanently lost		
	1980	1985	1990	1980	1985	1990
Elk	12	30 1/	40 1/	1,260	3,330 1/	4,130 1/
Mule Deer	54	140 1/	175 1/	2,740	7,240 1/	8,970 1/
Antelope	3	7 1/	9 1/	550	1,450 1/	1,795 1/
Sage Grouse 2/	14	36 1/	45 1/	820	2,170 1/	2,690 1/

1/ This is a cumulative loss from 1978 to 1985 to 1990.
2/ Loss of birds is a direct loss of strutting grounds.

In addition to permanently lost acreage, Table 4-18 shows the acreage temporarily disturbed during mining and construction. Revegetation would be going on simultaneously with new disturbance but would not create carrying capacities capable of supporting existing population before 1990. The revegetation process would restore 100 acres by 1980, 570 acres by 1985, and 2,600 acres by 1990. Table 4-18 shows the total acres disturbed, acres disturbed by species, and individual numbers to be displaced.

These species should be absorbed by the surrounding range. Winter range for elk, mule deer, and antelope is critical habitat. Their winter range contains sagebrush, mountain shrub, and aspen types. These types make up about 13,525 acres of the 19,800 total acres that would be temporarily disturbed by mining. This 13,525 acres is about 0.5 percent of the total sagebrush, mountain shrub, and aspen types available to these animals in the study area.

TABLE 4-18

TEMPORARY DISTURBANCE OF HABITAT AND DISPLACEMENT OF SPECIES ON A CUMULATIVE BASIS

Species	Numbers of individuals displaced			Acres of habitat temporarily disturbed		
	1980	1985	1990	1980	1985	1990
Elk	22	54	85	2,374	5,736	9,110
Mule Deer	100	245	390	5,160	12,470	19,800
Antelope	5	12	20	1,030	2,495	3,960
Sage Grouse 1/	26	60	100	1,550	3,740	5,940

1/ Sage grouse loss is due to a loss of three strutting grounds.

Sage grouse losses would probably be permanent because of the loss of strutting grounds, which are critical to their survival.

Legal and illegal hunting pressure would be expected to increase with the influx in the local human population.

Animal harassment would be expected to increase as more people spend their leisure time in the country, either on the roads or in off-road vehicles, mainly snowmobiles. Based on a current estimate from the Colorado Division of Wildlife of 600 road kills per year of big game animals and the estimated increased traffic volumes shown in the Transportation section of this chapter, development of additional federal coal would raise annual big game road kills in the study area to 1,000 by 1980, 1,100 by 1985, and 1,250 animals by 1990. Despite this increase, and loss of species from habitat disruption and harrassment, losses due to development at mid-level would not be significant compared to total wildlife populations.

Many animals would be destroyed during mining, road and railroad construction, and building of homes, schools, powerplants, etc. The less mobile faunal species such as reptiles, invertebrates, and small mammals would not be able to flee and would be destroyed. The larger and more mobile species such as deer, elk, coyote, and grouse and other birds would be able to move onto adjacent lands. These displaced animals would move into a less suitable location or an area that is already supporting populations in balance with their habitat. All or most of the displaced animals eventually could be lost as the total population would begin to adjust to the carrying capacity of the species' habitat and as interspecific and intraspecific intolerances would be resolved. The animals displaced would be in unfamiliar territories, and studies have indicated that most dislocated wildlife species are more vulnerable to predation than within their home ranges.

Food and cover shortages as well as spread of disease and parasites would also increase as population densities became greater.

Impacts on wildlife related to the increased noise level, especially around the mine area, could alter feeding and movement patterns for a variety of species.

Degradation of surface water would adversely impact terrestrial wildlife, by degrading the habitat of invertebrates, a major food item of a variety of terrestrial wildlife.

Fences on private surfaces which would not meet BLM Manual 1737 specifications from the BLM manual would account for the loss of some wildlife species. These specifications should mitigate approximately 90 percent of the fence kill loss.

Additional development of federal coal at mid-level would result in the same types of impacts for cumulative development at mid-level, but smaller in magnitude. Additional development of federal coal would result in a total disturbance of 1,610 acres by 1980, 5,955 acres by 1985, and 9,410 acres by 1990. This is only 20 percent of total mid-level disturbance by 1980, 30 percent of mid-level by 1985, and 33 percent of mid-level by 1990. These percentages would also apply to the relative adverse impact of additional development of federal coal on animal populations.

The permanently removed habitat from additional development of federal coal at mid-level would be 1,140 acres by 1980, 3,455 acres by 1985, and 4,410 acres by 1990. This represents 34 percent, 49 percent, and 50 percent of the impacts resulting from cumulative mid-level development by 1980, 1985, and 1990, respectively.

Half of all wildlife displaced permanently would be lost (Table 4-17). Elk lost would be 6 by 1980, 15 by 1985, and 20 by 1990. Deer lost: 27 by 1980, 70 by 1985, and 87 by 1990. Sage grouse lost: 7 by 1980, 18 by 1985, and 22 by 1990. Loss of antelope would be negligible.

One-third of all wildlife temporarily displaced would be lost (Table 4-14) Elk lost would be 7 by 1980, 16 by 1985, and 25 by 1990. Deer lost: 30 by 1980, 74 by 1985, and 120 by 1990. Sage grouse lost: 8 by 1980, 18 by 1985, and 30 by 1990. Antelope losses would be negligible.

The losses of these individuals would not be significant compared to the total population of these wildlife species in the study area. For example, the loss of 120 deer by 1990 averages 10 deer lost per year from 1978 to 1990. This is not significant compared to losses from disease, old age, hunting, poaching, harrassment, and animal-vehicle collisions. Significance of the losses of elk, antelope, and sage grouse is even smaller.

Threatened and Endangered Species

Threatened and endangered species would not be affected by additional

development of federal coal. Six species of endangered wildlife are known or believed to inhabit the study area. Four of the species are on the U.S. Department of the Interior's list of endangered fauna. These are the American peregrine falcon (Falco peregrinus), the black-footed ferret (Mustela nigripes), the whooping crane (Grus americana), and the bald eagle (Haliacetus leucoephalus). The other two, the river otter (Lutra canadensis) and the greater sandhill crane (Grus canadensis tabida) are on the State of Colorado's endangered fauna list.

Domestic Fauna

Coal development and related activities would affect the livestock industry of northwestern Colorado. Many county roads and state highways in the study area are used to trail livestock from one area to another. Livestock also occasionally find their way out of fenced ranges and onto roadways. This results in some animals being killed in collisions with vehicles. Records have not been kept of these incidences and the number of livestock lost is not known. With the increased vehicle traffic discussed in the Transportation Networks section of this chapter, loss of livestock would increase. The loss of an animal represents an economic loss to the owner. In the study area as a whole, these losses are not expected to be significant at the mid-level development. Accidential animal deaths would also be more likely from hunting-related activities. Rustling of livestock and damage to fences and other range improvement facilities would probably result from increases in human population and its use of the region. There are no estimates of these increases available, but they are not expected to be significant.

Loss of vegetative production measured in animal unit months (AUMs), discussed in the Vegetation section of this chapter, would decrease the numbers of livestock that could be grazed in the areas of coal mining. These areas are southwest Routt county, southeast Moffat county, and the area northeast of Meeker in Rio Blanco county. For specific losses of AUMs attributable to mid-level development, see the Vegetation section of this chapter and Table 4-16. This loss of production could be significant to an individual livestock operator, but would not be significant regionally. The significance to individual operators cannot be determined until coal mining operations are specifically proposed. For further discussion of economic impacts to livestock operations, see the Socio-Economic section of this chapter.

Within the study area, approximately ninety percent of the livestock grazing occurs on spring-summer-fall ranges. This range is normally not available for winter use due to heavy snow accumulations. Almost all of the loss of AUMs is expected to occur due to mid-level coal development on spring-summer-fall range.

Changes in surface water and ground water as discussed under the Water Resources section of this chapter could have an effect on livestock distribution near areas of coal development. The loss of small impoundments of water or water flow from wells supplying livestock could cause a reduction in numbers of livestock that could be supported in a given area. Due to the unpredictable nature of impacts to these water supplies, it is not known if there would be a significant impact to livestock operations. Effects of ground-water on vegetation are not expected to be significant to livestock.

Aquatic Biology

As additional coal development takes place in the study area adverse impacts to aquatic biology would result from population growth and developments ancillary to coal mining such as housing developments, power plants, and railroads. These developments would result in a permanent loss of aquatic habitat due to disturbance of land - 165 acres by 1980, 435 acres by 1985, and 540 acres by 1990. Disturbance due to development of additional federal coal would be 70 acres by 1980, 200 acres by 1985, and 265 acres by 1990. Destruction of habitat from accompanying increases in stream sedimentation during construction of roads, power plants, railroads, and housing developments would be localized and short-term.

Population growth would result in water treatment facilities being progressively overloaded and therefore water quality being degraded below population centers. This degradation of water quality would be long-term and would occur principally below Craig, Hayden, Steamboat Springs, and Oak Creek on the Yampa River and below Meeker on the White River. This impact cannot be quantified because it cannot be predicted exactly what types of facilities would be constructed to treat waste.

Loss of aquatic habitat would also occur due to developments along perennial streams and increases in agriculture-related activities. Construction of housing along streams would permanently claim about 25 acres of aquatic habitat by 1980, 135 acres by 1985, and 170 acres by 1990. Of this total, 19 acres would be attributable to development of additional federal coal by 1980, 66 acres by 1985, and 92 acres by 1990. As a result of land being disturbed for new housing, there would be more concentrated use of aquatic habitat in adjacent areas. There would also be a direct loss of habitat from expansion of agriculture-related activities necessary to support new population. Domestic animals would utilize and damage already limited riparian habitat.

The multiple impacts of population growth on fisheries are not expected to be of any significance, however. Areas that would be principally impacted do not have blue ribbon trout fisheries. Also, increases in sport fishing attributable to new population would not greatly affect these fisheries, but instead would increase the demand for a put-and-take trout fishery near the major population centers.

The impacts due to development of additional federal coal in comparison to total development at mid-level are shown in Table 4-19. Development of additional federal coal would represent about half of the total impacts at mid-level.

Threatened and Endangered Species

Threatened and endangered species of aquatic animals found in the study area would not be affected by additional development of federal coal. The White and Yampa Rivers provide habitat for the Humpback chub (Gila cypha) and the Colorado River squawfish (Ptychocheilus lucius), which are on the U.S.

List of Endangered Fauna and the Colorado List of Endangered Species. The White and Yampa Rivers also provide habitat for the humpback sucker (Xyraucher texanus) and the bonytail chub (Gila elegans) the former of which is on the Colorado List of Threatened Species, the latter on the Colorado List of Endangered Species. Portions of these rivers that are habitat for these animals would not be affected by mining and related activities.

TABLE 4-19

AQUATIC HABITAT CUMULATIVE IMPACTS (ACRES)

Impacts	1980	1985	1990
Impact due to development of additional federal coal			
Acres permanently disturbed	1,140	3,455	4,410
Aquatic habitat lost	70	200	265
Total mid-level scenario impacts			
Acres permanently disturbed	2,740	7,240	8,970
Aquatic habitat lost	165	435	540

Archeological Resources

The beneficial impacts to archeological resources from the projected mid-level production would be the inventorying, determining of significance, and preserving of sites in and around federal and state leases. The archeological sites found in these lease areas, however, may not yield as much information as sites chosen according to research-oriented criteria. In addition, there are other factors which could adversely effect the quantity and quality of the data gathered. Where excavation would be required, the immediate benefits would be published information and physical data stored for future comparison and study, but limited funding for excavation could limit or preclude ancillary studies which could yield paleoecological data. In addition, total excavation would preclude the use of data collection techniques which may be developed in the future.

Although legislation and mitigation require protection of surface sites on federal leases, adverse impacts of collection from and digging into sites can still occur.

Other unmitigated adverse impacts in coal development areas result from mining methods. In strip mine operations, unidentified surface and buried sites within the pit area would be assumed lost. Although lessees of federal coal are responsible for reporting the discovery of additional sites, the method of removing vegetation damages the integrity of sites and the methods of soil removal can remove whole sites without them being noticed. Damage to and loss of unidentified sites could also occur beyond mining areas, during construction of road, railroad, and stream protection devices. Subsidence above underground mines is another threat to archeological resources. Adverse impacts from cracking and settling due to subsidence are similar to those of erosion and sedimentation.

The unmitigated adverse impacts from state leasing would be the same as those possible on federal leases. Archeological resources on private coal leases have not been and may not be inventoried because there is no legal requirement that they be. These resources would be assumed lost.

It is difficult to attempt isolating and quantifying what additional impacts result directly from population increase due to coal development. Additional surveys would identify more sites and some of these would be eligible to the National Register of Historic Places (NRHP). Population growth would increase the possibility of vandalism or destruction of rock art and wickiups, casual collection from or uncontrolled digging into sites, and damage or destruction of sites by off-road vehicles. Population growth accompanying coal development could increase such losses not only in the study area but throughout northwestern Colorado and perhaps bordering areas of Utah and Wyoming. The very existence of road networks connecting all of these areas allows the casual collector easy access.

Growth of communities along the Yampa River and some of its tributaries would require additional land. Since archeological resources are often located along permanent streams, they would be impacted. Land developed without federal assistance or involvement would not be surveyed and the resources would be lost.

There is no feasible way to assess the percentages of impacts resulting from additional federal coal development. Some specific impacts resulting from mid-level production can be identified, but most of the federal and state coal development areas have not yet been surveyed and no predictive model exists to estimate site density or pattern. In addition, the state currently has no policy requiring survey. There is also no legal requirement for resources on private leases or in areas of community expansion to be identified or evaluated for significance.

By 1980 six private leases would be actively mined. Their resources would be considered lost. The three state leases to be mined have not been surveyed and cannot be assessed. Sixteen existing federal leases and any issued short-term leases would be active at mid-level. Eleven of the existing leases must be archeologically surveyed. Forty sites are presently recorded in areas of development. Six sites are presently recommended for inclusion on NRHP: 5MF435, 5MF444, 5MF680, 5RT18, 5RT30 and 5RT32 (see Table 2-23). Despite protective mitigation, casual collecting could occur at all sites that are not preserved through excavation and inventory. Rock art at several sites could be vandalized. Unidentified sites within the pit areas of federal and state leases would be lost. Community expansion would have developed 400 acres, of this, 320 acres would be attributable to development of additional federal coal. All sites that may exist in areas of community expansion would be assumed lost.

By 1985 ten private leases could probably be mined; their sites would be considered lost. At least eighteen existing federal leases and any issued short-term leases would be active. Fourteen of the existing federal leases need archeological survey. At least five state leases would be mined. These state leases have not been surveyed. Casual collection could continue to occur at all sites that are not preserved through excavation and inventory. Unidentified sites in the pit areas of federal and state leases would be lost. Community expansion would disturb 2,270 acres. Of this, 1,100 acres would be due to additional development of federal coal. Sites that may exist in areas of community expansion would be assumed lost.

By 1990, seven private leases being mined in 1985 could still be active. The resources on all ten private leases would be considered lost. Thirteen existing federal leases and any issued short-term leases would probably be active. Much of the area needs to be archeologically surveyed. At least four state leases would be mined and active. Surface collection could continue to occur on the 41 recorded sites and any additional sites found. Unidentified sites in the pit areas of federal and state leases would be lost. Community expansion would disturb 2,850 acres, of which 1,530 acres would be attributable to the development of additional federal coal. All known and as-yet-to-be-discovered sites in areas of community expansion would be assumed lost.

The majority of the 41 recorded sites appear to have data which should be important in describing adaptations of Plains Archaic technology that may have been developed in the eastern portion of the study area during a span of 5,000 years ago to 10,000 years ago. Data from these sites may be valuable to prehistoric reconstruction within the study area and within the Northwestern Plains. Several sites document the activities of historic Utes before they were moved to a reservation. Data from these resources may be important to reconstruction of Ute culture before and after contact with Europeans.

Historic Resources

The most damaging direct impact would result from earth disturbance when a specific mining site is developed; such disturbance includes roads, haulways, powerlines, portals, and structures all of which could destroy historic sites by displacement. Such sites could also be harmed by subsidence, but this impact would be minimal since lands subject to subsidence would have been inventoried and those sites located on lands prone to subsidence would have been recorded prior to development. There are presently no known historic sites on land disturbed by mid-level development but examination of the study area is incomplete.

Secondary impacts would occur when development changes the character of a region. For instance, historic sites could be vandalised at increased rates as a result of population increases and the attendant visitor use increases. The development of roads, and railroads, would degrade the integrity of historic sites located in the region and near development by altering the aesthetic surrounding (36 CFR 800.9).

A less obvious secondary impact would result from population increases in established towns such as Craig, Steamboat Springs, Meeker, and Oak Creek. New construction would displace older buildings and sites. However, certain areas both on the city and county level that are classified or zoned historic areas would be protected from rapid undisciplined development.

Aesthetics

Visual Resources

Impacts to the study area's visual resources would vary with the size and the visual sensitivity of specific sites of additional development of federal coal.

There are several activities of mining that would create stark contrasts to the existing landscape. Those associated with surface mining are:

- spoil piles or dump areas
- active pit(s)
- clearings
- associated haul roads, electrical and water rights-of-way, railroads
- associated structures
- lights at night

Those associated with underground mining are:

- flat areas for:
  - operations structures
  - coal storage
  - equipment storage
  - road, rail, and electrical and water rights-of-way

Ratings by BLM's Visual Resource Management system to indicate adverse impacts of additional development would depend on the determination of specific sites to be leased, so none can be given at present. However, areas most vulnerable to adverse impacts to visual resources can generally be indicated.

Eastern Routt County. Most of this area is visible from U.S. 40, Colorado 131, and the Hahn's Peak Road, and therefore would be visually impacted by mining. Scenic quality in most of the area is high, because of the landscape variety generated by vegetation, topography, and rivers and streams.

Mt. Harris Area. Landscape visibility in this area is less than in eastern Routt County, although areas adjacent to U.S. 40 have great exposure for short distances. View of landscapes further north and south is partially obscured by topography, so the visual impacts of mining would be more moderate. Scenic quality is characteristic to outstanding in the rolling-to-rugged mountain-high relief topography that dominates this area, extending from the Elkhead Mountains to the north to the Dunckley Flattops to the south.

Western Routt County and Eastern Moffat County. Except for the high visual sensitivity of landscape adjacent to U.S. 40, generally visual sensitivity is moderate in this area because access is provided by county roads, which are less traveled. Visual impacts would be moderate in this area.

Williams Fork Mountains. This landscape is highly visible from U.S. 40, Colorado 13, and the Williams Fork road and would be highly impacted by mining. Further south, near the Flattops, there is only moderate to low sensitivity, because of topographical features and limited access.

Axial Basin. Visibility of the Basin's rolling interior is moderate, but all peripheral lands have a high visual exposure. The Basin exhibits gently undulating landscapes of sagegrass types and agriculture, exhibiting minimal to characteristic scenic quality. Landscape variety on the Basin's periphery constitutes characteristic to outstanding scenery. Most of the eastern portion of the Basin has a high visual sensitivity, being visible from Colorado 13, and would be highly impacted by mining.

Meeker Area. Landscape visibility is moderate to high for most of the area and mining activities would have a great visual impact. Yellowjacket Pass, Ninemile Gap, and the Wilson Creek Oil Field mark the Danforth Hills divide that separates the Yampa and White River drainages. East of Meeker are the White River's pastoral and agricultural lands and near the National Forest boundary are great topographic definition and vegetative variety. These lands exhibit characteristic to outstanding scenery and would be highly impacted by mining. How these visually most sensitive areas would be affected by additional development of federal coal is not known until specific sites are chosen and ancillary development indicated.

Recreation

Impacts to recreation can generally be divided into loss of recreation opportunities (supply) and increases in recreation demand due to population increase. Coal mining and ancillary developments, regardless of site location, would impact recreation. Depending on the sites' recreation capabilities, ownership, and legal access, loss of these lands to mining and related activities would decrease the regions's supply of recreation opportunities.

When land is disturbed due to mining and ancillary developments, recreation opportunities are impacted in several ways. Access to recreation areas may be blocked. The mined area's natural landscape is disturbed through removal of vegetation and modification of topography, including removal of interesting rock formations. The mined area would no longer be useful for hiking, cross country skiing/snowshoeing, backpacking, nature study, photography, ORV activities, horseback riding, collecting, camping, and picnicking. Recreationists seeking to partake in these activities may be discouraged or prevented from using areas where subsidence from underground mining has resulted in surface cracking large enough to be a safety hazard to foot, horseback, or vehicle travel, especially motorcycling. However, cracking reaching the surface from subsidence is only expected to affect a small portion of the total area involved with mining because of the relately low proportion of underground mining. Geologic Setting earlier in this chapter contains a further analysis of subsidence impacts.

Displacement of wildlife would affect wildlife viewing and hunting. There would also be removal of cultural resources (see Cultural Resources). Removal of the fauna, rocks, and non-vertabrate fossils would result in the loss of collecting opportunities, although overburden removal often uncovers new rockhounding and fossil materials.

In 1990 for the mid-level scenario, there would be 28,770 acres of land disturbed. Of the 28,770 acres disturbed only 9,410 acres would be attributable to additional federal coal at mid-level. Cumulative disturbance due to development at mid-level would be 7,900 acres (1,610 acres due to additional federal coal at mid-level) from 1978-1980; 11,810 acres (4,345 acres due to additional federal coal at mid-level) from 1981-1985; and 9,060 acres (3,455 acres due to additional federal coal at mid-level) from 1986-1990. Besides this, there would be 8,970 acres of surface permanently removed from recreation use by 1990 of which 4,410 acres would be due to development of additional federal coal at mid-level. Acreage lost due to cracking or subsidence from underground mining is not included in the above figures since it presently cannot be predicted. Loss of recreation opportunities from land disturbance at mid-level would occur principally in Twenty-Mile Park and Hayden Divide south of Hayden, Nine Mile Gap northeast of Meeker, and the confluence area of the Yampa and Williams Fork Rivers southwest of Craig.

Loss of land during active mining operations would result in loss of habitat for wildlife (see Wildlife). Loss of wildlife habitat results in loss of animals and eventual loss of hunting and wildlife viewing opportunities. Loss of hunting opportunities is a direct result of loss of animals, as discussed in the Wildlife section. The impact on hunting is difficult to predict because hunters are usually unaware of changes in wildlife numbers from one hunting season to the next. Hunters may also be reluctant to hunt near a mining operation because of the feeling that animals may have abandoned the area or that animals in the area have been harassed and would be more difficult to hunt. However, there is so much opportunity for hunting in the study area that the effect of mining is expected to be insignificant.

There would be no loss of fishing opportunities because none of the region's fisheries would be impacted (see Aquatic Biology).

Some of the mining would create beneficial impacts in that the mining activity provides a human-interest feature for people to view and enjoy. Mining facilities also have tremendous educational opportunities.

Mining, specifically the removal of overburden, would uncover cultural materials, fossils, and rockhounding materials, but these could either be destroyed during stripping or covered and lost again when backfilling occurs. Mining Health and Safety Administration (MHSA) requires that archaeologists, paleontologists, and recreationists not be permitted in the area of the high-wall during the mining. Nor would off-road vehicle enthusiasts be permitted to ride on the mine spoils unless special provisions can be made.

Population in the study area for the mid-level scenario is as follows: 1977 - 25,929; 1980 - 29,900 (4,000 increase); 1985 - 48,600 (22,700 increase); and 1990 - 54,400 (28,500 increase).

As noted in the recreation section of Chapter V, NWCCRES, increases in outdoor recreational activity also increase the demand for urban recreation in the region. According to Table RII-26 of the NWCCRES, Routt County had deficiencies of 11,200 activity days for swimming and 2,900 days for tennis. Moffat County had a deficiency of 14,900 activity days for tennis, but none for swimming. Rio Blanco did not have deficiencies in either swimming or tennis. This county data is only applicable to 1974. The data has not been broken down by city. Projections for the future could not be made because no data were available. However, deficiencies which already exist would be expected to increase as population would increase.

All developed recreation sites within the region would be expected to have minor impacts from increased recreation demands resulting from cumulative development at mid-level. These impacts would be permanent and would increase gradually from 1980 to 1990. Those areas closest to municipal centers would be affected most. These include Ralph White Reservoir, Elkhead Reservoir, Ferndale, Harrison Creek, and Cristina

Picnic Grounds, Meadows, Dry Lake and Summit Creek Campgrounds, and Lake Avery and Rio Blanco Lake State Recreation Areas (see Map Foldout 12 in Appendix B, NWCCRES).

Development at mid-level would not impact wilderness values. However, population increases resulting from this development would increase the demand for wilderness recreation. The Flat Tops Wilderness Area and the Mt. Zirkel Wilderness Area are the only two formally designated wilderness areas in the region. Currently, BLM is inventorying its lands for wilderness potential. There is no data from which to make projections of impacts on wilderness values due to population increases, but they may be minimal because many wilderness opportunities occur in the study area. Several of these areas are administered by BLM and will probably become designated wilderness areas some day.

An estimated 100,000 visitor days of off-road vehicle use occur in the study area. A major portion of this is snowmobile use in Routt and White River National Forests. Population growth from cumulative development at mid-level is anticipated to have permanent but minor impacts on this resource because there currently appears to be a regional surplus of ORV opportunities in the study area. The impacts of ORV activity would be disruption of mood-atmosphere qualities, loss of vegetation, loss of soil, and harassment of wildlife.

No data is available to quantify other recreation impacts from population growth but they would be considered minor because, based on data presented in the 1974 Colorado State Comprehensive Outdoor Recreation Plan, there is generally a surplus of recreation opportunities available within the study area. Losses of recreation opportunities in mining areas would therefore be negligible.

Those recreation opportunities that would be impacted by mid-level coal development would be considered permanent losses because, even though the land would be reclaimed, it would probably never again be able to attract recreation use similar to its earlier natural capability. Rockhounding, however, could still be carried on, if some of the overburden would be left exposed. Also, reclaimed areas could provide ORV opportunities.

The recreation section of Chapter 5, NWCCRES, also notes that with increased population, there is increased pressure on towns' sewage treatment facilities, which would lead to increased fecal coliform levels in the Yampa and White Rivers. These increases could make the Yampa River ineligible for designation under the Wild and Scenic Rivers Act.

Demography

All three counties and most municipalities (except Dinosaur and Yampa) would experience significant increases in population with additional development of federal coal at mid-level (Table 4-18). Additional coal-related employment within driving distance of Craig would, in the short-term, only partly compensate for the loss of construction jobs at the Craig Power Plant by 1980 (Table 4-19). Craig's population would drop to 5,500 by 1980, or 18 percent below the 1977 level of 6,677. However, by 1990 Craig's population would reach 13,900, or more than double its current population. Population trends in Moffat County as a whole would mirror developments in Craig: an 11 percent decline in population between 1977 and 1980 followed by a period of steady population growth, reaching 17,700 by 1990. Dinosaur's small (347 in 1977) population would peak at 525 by 1985, then decline to 480 by 1990.

Additional development of federal coal would have only a limited impact on Rio Blanco County, the impact attributable to workers in Moffat County coal mines electing to live in Meeker. However, the region-wide increase in economic activity under mid-level development would stimulate Rio Blanco's business and consumer-serving industries, which are centered in Meeker and Rangely. Meeker's population would grow from 1,848 in 1977 to 9,400 by 1985, before declining to 8,700 in 1990. Rangely would grow from 1,871 to 4,700 inhabitants by 1985, then decline to 4,400 five years later. The decline in both towns would result from construction worker layoffs following completion of the three oil shale projects in the county. Total county population would grow to 15,500 by 1985 (1,600 due to additional development of federal coal), then decline to 14,500 in 1990 (1,600 due to additional federal coal).

Total population of the three-county area would grow from 25,929 in 1977 to 54,700 by 1990 (15,700 due to additional federal coal).

Based on historical experience (see Chapter 2, Socio-Economic Environment), it is probable the bulk of new workers arriving to take additional jobs foreseen with mid-level development would probably be young (i.e., aged 20-34), since persons in this age group are more likely to travel long distances in search of work than older people with family and other roots in a specific locality. Furthermore, the prevalence of male-oriented occupations (mining, construction) among the new job opportunities and the likelihood that many young male workers would be unmarried or would leave their families behind suggests that the greater part of the new workers would be males.

The geographical distribution of this population would also be altered somewhat by mid-level development. By 1990, 88 percent of the region's population would be living in places classified as urban (i.e., over 2,500 inhabitants).

TABLE 4-18

PROJECTED POPULATION RELATED TO ADDITIONAL
DEVELOPMENT OF FEDERAL COAL AT MID-LEVEL, 1977-1990 1/

County City	1977	1980	1985	1990
Moffat	0	1,300	4,300	7,700
Craig	0	1,300	4,275	7,675
Dinosaur	0	0	25	25
Rio Blanco	0	100	1,500	1,700
Meeker	0	50	1,000	1,100
Rangely	0	50	500	600
Routt	0	1,200	5,100	8,900
Hayden	0	300	1,600	3,000
Oak Creek	0	300	800	1,200
Steamboat Springs	0	600	2,700	4,600
Yampa	0	0	0	0
Total	0	2,600	10,900	18,300

1/ Community totals may not equal county figures and may not coincide exactly with Table 4-18 due to independent rounding.

TABLE 4-19

POPULATION PROJECTIONS FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL
1977-1990

County City	1977	1980	Average annual rate of change (%) 1977-1980 1/	1985	Average annual rate of change (%) 1980-1985	1990	Average annual rate of change (%) 1985-1990 1/	Average annual rate of change (%) 1977-1990 1/
Moffat	10,313	9,100	-4	14,000	9	17,700	5	4
Craig	6,677	5,500	-6	10,100	13	13,900	7	6
Dinosaur	347	375	2	523	7	485	-2	3
Rio Blanco	5,100	8,000	16	15,500	14	14,500	-1	8
Meeker	1,848	4,500	35	9,400	16	8,700	-2	13
Rangely	1,871	2,100	3	4,700	18	4,400	-1	6
Routt	10,516	12,200	5	19,100	9	22,200	3	6
Hayden	1,362	2,000	13	3,900	15	6,000	9	12
Oak Creek	756	750	- 2/	1,700	17	2,500	8	10
Steamboat Springs	4,028	5,100	8	9,000	12	12,200	6	9
Yampa	307	320	1	365	3	360	- 2/	1
Total	25,929	29,300	5	48,600	11	54,400	2	6

1/ Compounded annually.
2/ Less than 1 percent.

Economics

Employment. Table 4-20 presents employment projections attributable to additional development of federal coal at mid-level. Impacts of employment would be greatest in Routt County (an additional 1,760 jobs by 1990), followed by Moffat (670 new jobs) and Rio Blanco (600 additional jobs).

Table 4-21 projects trends in sector employment by county resulting from cumulative development at mid-level. The implications of mid-level development are most immediately apparent for Moffat County. By 1980, additional coal-related employment would help to cushion the impact that completion of the Craig Power Plant and disbanding of its 1,472-man construction workforce would otherwise have on the local economy. Total employment in Moffat County would fall to 4,980 (140 due to additional federal coal) with an increase of employment in mining (110 workers) as well as additional indirect and induced employment in other sectors.

Total employment in Moffat County would be 6,180 in 1985 (Table 4-22) (370 due to additional federal coal) and 6,790 in 1990 (670 due to additional federal coal). Between 1977 and 1990 there would be a small net gain in employment (304 jobs) with mid-level development.

By 1990, Moffat County would be slightly more dependent upon coal mining employment at mid-level (Table 4-23) (17 percent of total employment, 2 percent of total employment attributable to additional federal coal). Increased employment due to coal would probably not result in any significant short-term labor shortages, because of the buffering effect of residual unemployment caused by completion of the Craig Power Plant.

Rio Blanco County would experience little impact due to mid-level coal development, since little additional coal development would occur there and relatively few of the new coal mining employees would live there. Whatever small increase in employment would occur as a result of additional coal development would have little cushioning effect on the expected employment decline following completion of local oil shale projects. Employment in Rio Blanco County would be 10,690 in 1990, 600 due to additional federal coal.

Mid-level coal development would have a substantial impact on employment in Routt County, both from coal mining and from indirect and induced employment. From 1,245 employees in 1980, mining employment would rise to 2,600, 1,400 due to additional federal coal. Total mid-level employment in Routt County by 1990 would reach 9,990. 1,760 due to additional federal coal. The relative importance of mining as a source of local employment would increase correspondingly, to 26 percent of total employment.

The increase in coal mining employment in Routt County, although rapid, would probably not result in any significant short-term labor shortages in other sectors. The presence in Routt County of a relatively large unemployed labor force (see Chapter 2, Socio-Economic Environment) would help to mitigate the labor shortages which otherwise might occur, with the mines competing with other employers for limited available employees.

TABLE 4-20

MID-LEVEL SCENARIO: PROJECTED EMPLOYMENT ATTRIBUTABLE TO ADDITIONAL DEVELOPMENT OF FEDERAL COAL AT MID-LEVEL 1980-1990

County	1980			1985			1990		
	Direct	Indirect/ Induced	Total	Direct	Indirect/ Induced	Total	Direct	Indirect/ Induced	Total
Moffat	110	30	140	160	210	370	250	420	670
Rio Blanco	95	20	115	220	90	310	430	170	600
Routt	485	100	585	1,180	170	1,350	1,400	360	1,760
Total	690	160	850	1,560	470	2,030	2,080	950	3,030

TABLE 4-21

PROJECTED EMPLOYMENT BY SECTOR AT
CUMULATIVE MID-LEVEL DEVELOPMENT
1980

Sector	Moffat		Rio Blanco		Routt	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
Agriculture	190	4	130	2	170	3
Manufacturing	140	3	60	1	150	2
Coal mining	900	18	115	2	1,245	20
Oil and gas extraction	0	0	730	12	0	0
Shale oil extraction	0	0	0	0	0	0
Construction	490	10	3,290	53	550	9
Transportation, utilities, communications	500	10	300	5	380	6
Trade	480	10	350	6	1,010	16
Finance, insurance, real estate	180	4	80	21	430	7
Services	550	11	300	5	1,120	18
State and local government	1,460	29	760	12	970	16
Federal government	90	2	50	1	100	2
Total 1/	4,980	100	6,165	100	6,125	100

1/ Totals may not add to 100 percent due to rounding.

TABLE 4-22

PROJECTED EMPLOYMENT BY SECTOR AT
CUMULATIVE MID-LEVEL DEVELOPMENT
1985

Sector	Moffat		Rio Blanco		Routt	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
Agriculture	200	4	140	1	180	2
Manufacturing	220	4	90	1	230	3
Coal mining	1,140	18	240	2	2,350	28
Oil and gas extraction	0	0	1,040	10	0	0
Shale oil extraction	0	0	1,600	15	0	0
Construction	490	8	3,990	37	510	6
Transportation, utilities, communications	700	11	380	4	500	6
Trade	620	10	830	8	1,240	15
Finance, insurance, real estate	260	4	120	1	620	7
Services	670	11	680	6	1,320	16
State and local government	1,770	29	1,570	15	1,370	16
Federal government	110	2	60	1	130	2
Total 1/	6,180	100	10,740	100	8,450	100

1/ Totals may not add to 100 percent due to rounding.

TABLE 4-23

PROJECTED EMPLOYMENT BY SECTOR AT
CUMULATIVE MID-LEVEL DEVELOPMENT
1990

Sector	Moffat		Rio Blanco		Routt	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
Agriculture	200	3	140	1	180	2
Manufacturing	260	4	110	1	280	3
Coal mining	1,150	17	450	4	2,600	26
Oil and gas extraction	0	0	1,560	15	0	0
Shale oil extraction	0	0	4,560	43	0	0
Construction	580	9	220	2	580	6
Transportation, utilities, communications	780	12	420	4	560	6
Trade	680	10	780	7	1,460	15
Finance, insurance, real estate	300	4	140	1	720	7
Services	740	11	620	6	1,650	17
State and local government	1,950	29	1,600	15	1,780	18
Federal government	150	2	90	1	180	2
Total 1/	6,790	100	10,690	100	9,990	100

1/ Totals may not add to 100 percent due to rounding.

Income. Table 4-24 contains projections (in 1976 dollars) of wage and salary earnings attributable to additional development of federal coal at mid-level. On an areawide basis, these earnings would grow from $12.2 million in 1980 to $40 million by 1990, most of which would be directly attributable to mining.

Wage and salary earnings at mid-level for the three-county area would be $200.2 million in 1980, rising to $300.2 million by 1990. Routt County would experience the greatest impact with total earnings of $113.1 million in 1990.

Since the bulk of this growth would be concentrated in the coal mining sector, the latter's percentage share in total Routt County earnings would grow to 38 percent by 1990 (Tables 4-25, 4-26, and 4-27). Thus, while injecting large additional amounts of wage and salary income into the Routt County economy this growth would also make the local economy more vulnerable to disruptions in the coal market. Such disruptions might result from a nationwide rail strike or a disadvantageous shift in the relative price of coal versus other types of energy.

The cumulative impact of the mid-level scenario on the wage and salary structure of the Moffat County economy would be similar in nature, although less in degree than the impact on Routt County. Increased employment due to coal mining at mid-level would absorb some of the economic slack caused by completion of the Craig Power Plant; the 1977-1980 decline in earnings would be $21.2 million, or 29 percent. Moreover, by 1990 mid-level wage and salary earnings would be $70.5 million. The average wage level of workers residing in Moffat County in 1990 would also increase correspondingly to $10,906, $500 of which would be due to additional federal coal. A possible long-term negative tradeoff for these benefits would be a moderate increase in Moffat County's already high proportional dependence on mine earnings (to 25 percent in 1990). As noted in the case of Routt County, this would increase Moffat's economic vulnerability to market or logistical disruptions in the flow of coal.

The cumulative earnings impact on Rio Blanco County at mid-level would be relatively minor, with total wage and salary earnings reaching a maximum of $133.1 million in 1985. Thereafter, additional earnings in Rio Blanco County indirectly related to mid-level coal mining activities in the adjacent counties would have a very slight cushioning effect on the aggregate decline in Rio Blanco earnings projected to result from completion of oil shale installations. Individual average wage and salary income for Rio Blanco County residents at mid-level would decline to $10,948 by 1990. Of this decline, $44 would be due to the increase in less well-paid trade, services, and other employment in Rio Blanco County responding to additional development of federal coal in adjacent portions of Moffat County.

Increased aggregate and average wage and salary earnings at mid-level would intensify inflationary pressures in Rio Blanco (at least through 1985) and Routt Counties. In Moffat County, these earnings would counteract the

TABLE 4-24

MID-LEVEL SCENARIO: PROJECTED WAGE AND SALARY EARNING ATTRIBUTABLE TO ADDITIONAL DEVELOPMENT OF FEDERAL COAL AT MID-LEVEL (thousands of 1976 dollars)
1980-1990

County	1980			1985			1990		
	Direct	Indirect/ induced	Total	Direct	Indirect/ induced	Total	Direct	Indirect/ induced	Total
Moffat	1,704	400	2,104	2,479	1,781	4,260	4,028	3,573	7,601
Rio Blanco	0	241	241	0	64	64	0	1,217	1,217
Routt	9,063	774	9,837	21,766	1,464	23,230	28,351	2,874	31,225
Total	10,767	1,415	12,182	24,245	3,309	27,554	32,379	7,664	40,043

TABLE 4-25

PROJECTED WAGE AND SALARY EARNINGS AT
CUMULATIVE DEVELOPMENT AT MID-LEVEL
1980

	Moffat		Rio Blanco		Routt	
	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total
Agriculture	1,035	2.0	706	0.8	911	1.4
Manufacturing	1,568	3.0	647	0.8	1,612	2.5
Coal mining	13,943	26.8	1,782	0.2	19,287	30.0
Oil and gas extraction	0	0.0	9,671	11.5	0	0.0
Shale oil extraction	0	0.0	0	0.0	0	0.0
Construction	8,161	15.7	55,787	66.4	9,219	14.4
Transportation, communications, utilities	6,418	12.3	3,734	4.4	4,783	7.4
Trade	3,816	7.3	2,812	3.3	8,123	12.6
Finance, insurance, real estate	1,409	2.7	650	0.8	3,366	5.2
Services	4,252	8.2	2,327	2.8	8,682	13.5
State and local government	10,029	19.3	5,190	6.2	6,668	10.4
Federal government	1,353	2.6	732	0.9	1,576	2.5
Total 1/	51,984	100.0	84,038	100.0	64,227	100.0
Average wage and salary income per worker (residence adjusted)	10,747		12,361		10,243	

1/ Percentages may not add to 100.0 percent due to rounding.

TABLE 4-26

PROJECTED WAGE AND SALARY EARNINGS AT
CUMULATIVE DEVELOPMENT AT MID-LEVEL
1985

	Moffat		Rio Blanco		Routt	
	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total
Agriculture	1,073	1.7	733	0.5	944	1.0
Manufacturing	2,379	3.7	1,009	0.7	2,565	2.8
Coal mining	17,661	27.5	3,718	2.7	36,406	39.9
Oil and gas extraction	0	0.0	13,855	10.1	0	0.0
Shale oil extraction	0	0.0	21,255	15.5	0	0.0
Construction	8,144	12.7	67,017	49.0	8,598	9.4
Transportation, communications, utilities	8,753	13.6	4,695	3.4	6,244	6.8
Trade	4,985	7.8	6,618	4.8	9,906	10.9
Finance, insurance, real estate	2,043	3.2	939	0.7	4,869	5.3
Services	5,211	8.1	5,219	3.8	10,189	11.2
State and local government	12,194	19.0	10,820	7.9	9,404	10.3
Federal government	1,815	2.8	987	0.7	2,133	2.3
Total 1/	64,258	100.0	136,865	100.0	91,258	100.0
Average wage and salary income per worker (residence adjusted)	10,882		11,894		10,443	

1/ Percentages may not add to 100.0 percent due to rounding.

TABLE 4-27

PROJECTED WAGE AND SALARY EARNINGS AT
CUMULATIVE DEVELOPMENT AT MID-LEVEL
1990

	Moffat		Rio Blanco		Routt	
	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total
Agriculture	1,095	1.6	739	0.6	960	0.9
Manufacturing	2,828	4.0	1,195	1.0	3,015	2.8
Coal mining	17,816	25.3	6,971	5.6	4,280	38.0
Oil and gas extraction	0	0.0	20,750	16.8	0	0.0
Shale oil extraction	0	0.0	60,535	49.0	0	0.0
Construction	9,655	13.7	3,677	3.0	9,655	9.1
Transportation, communications, utilities	9,790	13.9	5,294	4.3	7,005	6.6
Trade	5,425	7.7	6,227	5.0	11,692	11.0
Finance, insurance, real estate	2,348	3.3	1,080	3.9	5,597	5.6
Services	5,736	8.1	4,840	4.2	12,810	11.9
State and local government	13,349	18.9	10,930	8.8	12,201	11.5
Federal government	2,452	3.5	1,337	1.1	2,866	2.7
Total 1/	70,494	100.0	123,575	100.0	106,081	100.0
Average wage and salary income per worker (residence adjusted)	10,906		10,948		10,439	

1/ Percentages may not add to 100.0 percent due to rounding.

recessionary impact that completion of the Craig Power Plant would have, exerting a further moderate inflationary pressure on local price levels. Increasing prices would detract from real income among all residents, although highly-paid mine workers would be less hardhit than persons on low or fixed incomes.

Investment. Table 4-28 lists anticipated incremental (private) investment related to additional development of federal coal and cumulative levels of private investment under the mid-level scenario. Anticipated investments in the three-county area would be $13.2 million between 1978 and 1980, $20.1 million from 1981 to 1985, and $4.7 million from 1986 to 1990. Cumulative mid-level investment in the three-county region would be $1,144.6 million between 1978 and 1980, $904.1 million from 1981 to 1985, and $500.9 million from 1986 to 1990.

The economic effects of investment in coal mining (e.g., jobs, income) would be felt throughout the three-county area, but would be concentrated in Moffat and Routt Counties. The direct fiscal benefits in terms of increased property tax assessments on the mines would be confined to Moffat and Routt Counties and the school districts in which the mines would be located. The property tax base of nearby municipalities would benefit only indirectly, from assessments on new worker housing and associated commercial development.

Retail Sales. Table 4-29 contains projections (in 1976 dollars) of retail sales at mid-level. Total areawide sales would be $239.4 million in 1980, $355.4 million in 1985, and $376.3 million in 1990. The portion of cumulative areawide retail sales attributable to additional development of federal coal is as follows: $4.9 million (1980); $13.4 million (1985); and $18.4 million (1990).

These increases would be felt to varying degrees throughout the study area, but impacts would be especially noticeable in southeast Moffat and southwest Routt Counties (areas of coal development). By 1990, sales in Moffat County would be $89 million. In Craig alone projected 1990 sales would be $73.6 million. The increment of retail sales attributable to development of federal coal by 1990 would reach $4.1 million in Moffat County and $2.6 million in Craig.

In Routt County the impact on retail trade would be even greater: $14.8 million in sales attributable to additional development of federal coal and sales of $129.3 million attributable to cumulative development by 1990. Once again, impacts would be concentrated in Steamboat Springs, where sales due to cumulative development would reach $86.9 million, of which 9.9 million would be due to federal coal.

Local Services

The impact of projected population growth at mid-level on local services would vary widely among individual communities. Public services and facilities

TABLE 4-28

MID-LEVEL SCENARIO: EXPECTED MAJOR PRIVATE INVESTMENTS
BY COUNTY, 1978-1990 (MILLIONS OF 1976 DOLLARS)

Sector/County	1978-1980	1980-1985	1985-1990
Non-coal investments			
Moffat	90.0	50.0	0.0
Rio Blanco	1000.0	800.0	450.0
Routt	8.3	28.2	46.2
Coal mining investments (not including additional development of federal coal)			
Moffat	24.9	0.0	0.0
Rio Blanco	0.0	0.0	0.0
Routt	8.2	5.8	0.0
Additional development of federal coal investments			
Moffat	1.2	1.6	2.2
Rio Blanco	0.0	0.0	0.0
Routt	12.0	18.5	2.5
Total mid-level investments			
Moffat	116.1	51.6	2.2
Rio Blanco	1000.0	800.0	450.0
Routt	28.5	52.5	48.7
3-County Region	1144.6	904.1	500.9

TABLE 4-29

CUMULATIVE PROJECTED RETAIL SALES AT MID-LEVEL
1980-1990

County City	Projected annual retail sales (thousands of dollars) 1980	1985	1990
Moffat	61,803	80,792	89,017
Craig	51,111	66,815	73,617
Dinosaur	618	808	890
Rio Blanco	103,286	170,999	158,003
Meeker	31,606	52,326	48,349
Rangely	60,732	100,547	92,906
Routt	74,305	103,587	129,265
Hayden	4,087	5,697	7,110
Oak Creek	1,932	2,693	3,361
Steamboat Springs	49,859	69,507	86,737
Yampa	817	1,139	1,422
Total	239,394	355,378	376,285

in a number of communities in the three-county area would be overloaded. In the short-term such adverse impacts would constitute a hardship for newcomers as well as long-term residents.

In the following discussion, projected service levels in individual communities are compared with commonly accepted service standards and planning guidelines in order to obtain a readily quantifiable assessment of probable impacts. Such yardsticks, however, afford only a limited measure of the impact of development upon residents' lives.

Perhaps the simplest example is fire protection: while inadequate fire protection may not actually lead to a sudden rash of highly destructive fires, it would certainly lead to deterioration in local fire insurance ratings and an increase in insurance premiums for local residents and businesses. Inadequate police coverage could lead to an increase in crime and/or traffic problems. Whether or not these effects occur, apprehension and insecurity could increase among many local residents for whom the police officer on patrol is a readily visible source of reassurance.

An inadequate water supply or treatment facility could affect residents' lives in the form of insufficient water pressure (which may also impede firefighters and lower insurance ratings), rationing of available water supplies, and unpleasant-tasting drinking water. Substandard sewage treatment facilities could cause pollution of nearby waterways and create disagreeable smells. In extreme cases, such facilities could be shut down by the state or the U.S. Environmental Protection Agency.

In all cases, local residents must pay the cost of programs to ameliorate these conditions (e.g., hiring new policemen, expanding sewage treatment facilities), although financial assistance may be available from outside sources (see discussion of local community finances). In most cases, these services should begin to catch up with the population in the middle term. In the long term, more and better services should be available to all.

Municipal service requirements likely at mid-level are presented in Table 4-30, Police Service, Table 4-31, Fire Service, Table 4-32, Water Supply, and Table 4-33, Sewage Treatment. Following is a summary of the implications of population growth at mid-level for each community's municipal services.

Craig. The present sewage treatment facility and water supply would remain adequate through 1990, while police and fire departments would require additional manpower and equipment from 1985 to 1990. This would be attributable to the additional development of federal coal.

Dinosaur. Current service levels would remain adequate through 1990 with the exception of law enforcement. One additional police officer and one additional patrol car would be needed beginning in 1980 at mid-level. Neither the police officer nor the patrol car would be due to additional development of federal coal alone.

TABLE 4-30

POLICE SERVICE REQUIREMENTS AT CUMULATIVE DEVELOPMENT AT MID-LEVEL

Town	Current service		1980 4/		1985 4/		1990 4/	
	Officers	Patrol cars	Officers	Patrol cars	Officers	Patrol cars	Officers	Patrol cars
Craig	17 (h) 2/	6 (a) 3/	11	4	17	6	24	8
Dinosaur 1/	0	0	1	1	1	1	1	1
Meeker	4 (a)	2 (h)	9	3	19	6	18	6
Rangely	4 (a)	4 (h)	4	1	9	3	9	3
Hayden	3 (a)	2 (h)	4	1	8	3	12	4
Oak Creek	1 (i)	1 (h)	2	1	3	1	5	2
Steamboat Springs	14 (a)	6 (h)	21	7	32	11	43	14
Yampa	1 (a)	1 (h)	1	1	1	1	1	1

1/ County deputy lives in the town.
2/ Assessment of current service levels based on accepted national police planning standards: (a) for towns over 10,000, 1.7 officers per 1,000 population is adequate; for towns under 10,000, 2 officers per 1,000 population is adequate; (h) indicates above average level; and (i) is below adequate level.
3/ The accepted national standard for adequate (a) patrol vehicles is 1 car per 3 officers, (h) would be less than 3 officers per car.
4/ Future service needs based on adequate service standards.

TABLE 4-31

FIRE SERVICE REQUIREMENTS AT CUMULATIVE DEVELOPMENT AT MID-LEVEL

Town	Area served	Current pumping capacity 1/	1980 Required pumping capacity	1985 Required pumping capacity	1990 Required pumping capacity
Craig	Metropolitan area	2,800	2,500	3,000	3,500
Dinosaur	City limits	750	500	500	500
Meeker	City limits	1,225	2,250	3,000	3,000
Rangely	City limits	1,000	1,500	2,250	2,250
Hayden	Town plus radius of 10 miles county	3,250	1,500	2,000	2,500
Oak Creek	Metropolitan area	1,250	500	1,500	1,750
Steamboat Springs	Metropolitan area	1,250	3,500	4,500	5,000
Yampa	City limits	250	500	500	500

1/ Pumping capacity shows the combined gpm (gallons pumped per minute) of a fire department's fire fighting vehicles.

TABLE 4-32

WATER SUPPLY REQUIREMENTS AT CUMULATIVE DEVELOPMENT AT MID-LEVEL

Town	Current maximum capacity (MGD) 1/	1980			1985			1990		
		Maximum 2/ demand (MGD)	Excess capacity (%)	Over capacity (%)	Maximum 2/ demand (MGD)	Excess capacity (%)	Over capacity (%)	Maximum 2/ demand (MGD)	Excess capacity (%)	Over capacity (%)
Craig	5.0	1.6	68		3.0	40		4.2	16	
Dinosaur	.274	.112	59		.158	42		.145	47	
Meeker	2.9	1.4	52		2.8	3		2.6	10	
Rangely	2.16	.617	71		1.4	35		1.3	40	
Hayden	1.3 3/	.589	55		1.2	8		1.8		38
Oak Creek	1.4	.229	84		.510	64		.746	47	
Steamboat Springs (winter)	5.0	3.7	26		5.6		12	7.7		54
Yampa	1.2	.095	91		.110	87		.108	84	

1/ MGD = million gallons per day.
2/ Colorado state planning office standard for maximum (peak) daily demand = 300 gallons per day per capita.
3/ Hayden water supply currently not able to meet demand. New plant to be functioning summer 1978 with the maximum capacity of 1.3 MGD.

TABLE 4-33

SEWAGE TREATMENT REQUIREMENTS AT CUMULATIVE DEVELOPMENT AT MID-LEVEL

Town	Current treatment capacity (MGD) 1/	1980			1985			1990		
		Treatment demand 2/ (MGD)	Excess capacity (%)	Over capacity (%)	Treatment demand 2/ (MGD)	Excess capacity (%)	Over capacity (%)	Treatment demand 2/ (MGD)	Excess capacity (%)	Over capacity (%)
Craig	2.5	.921	63		1.7	32		2.3	8	
Dinosaur	.17	.063	63		.088	48		.081	53	
Meeker	.4	.761		90	1.6		300	1.5		275
Rangely	1.7	.346	80		.782	54		.738	57	
Hayden 3/	.73	.330	56		.660	12		1.0		33
Oak Creek	.35	.128	63		.286	18		.418		19
Steamboat Springs (winter)	2.4	2.1	13		3.1	29		4.3		79
Yampa	.084	.053	37		.061	27		.061	27	

1/ Million gallons per day.
2/ Based on national and Colorado state planning standard of 168 gallons per day per capita.
3/ Hayden's present facility has the capacity to handle population demand through 1990. However, the system has water infiltration problems which can add up to .471 MGD to the system. Once the new facility is constructed (est. 1980-81) infiltration should no longer present a problem.

Meeker. An upward trend in population would impact local services through 1985. The slight population decrease by 1990 would create a very small excess capacity at mid-level if the community were to meet the 1985 peak demand. Sewage treatment capacity would be overloaded even without additional federal coal development. Fifteen additional police officers would be needed by 1985 when population would peak, two of these attributable to additional federal coal. Four additional patrol cars would be needed by 1985. The fire department would need two additional pumpers with a combined capacity of 1,775 gpm to meet service requirements by 1990. Neither the patrol cars nor the fire pumpers would be attributable to additional development of federal coal alone.

Rangely. Projected population growth at mid-level would require manpower and equipment increases in the police and fire departments, while present water and sewage treatment capabilities would be adequate to handle the increased demand. The police department would have to recruit five additional officers to meet projected service demands by 1985 though 1990, one of these due to additional federal coal. An additional pumper truck would have to be purchased to bring the current pumping capacity up to standard and would need a capacity of 1,250 gpm to meet long range requirements at mid-level, 250 gpm of this attributable to additional federal coal.

Hayden. Hayden is currently experiencing problems in water and sewage treatment services and population growth at mid-level would magnify these problems. A new water facility expected to be functional by summer 1978 would be adequate to meet projected population demands through 1985, but, by 1990 population would require 1.0 MGD (38 percent over present capacity), 0.9 MGD of this due to additional federal coal. By 1990, mid-level population would create a 33 percent overload on the sewage treatment facility. The police department would have to recruit four additional officers by 1985 and four more by 1990. Two of these officers would be attributable to additional federal coal.

Oak Creek. Population at mid-level would create shortages in fire, police, and sewage treatment services, all due to additional federal coal.

Steamboat Springs. Expansion of current water and sewage treatment facilities as well as additional manpower and equipment for the police and fire departments would be required at mid-level. The sewage treatment facility would be overloaded by 1985, earlier with development of additional federal coal. Population demands for water by 1985 would exceed capacity by 12 percent. A total police force of 43 would be needed by 1990, 7 attributable to additional federal coal.

Yampa. The current local service level of police, water, and sewage treatment would remain adequate through 1990. The fire department needs upgrading to meet current population requirements; doing so would meet population demands through 1990.

Housing

Population change in northwest Colorado projected for mid-level development would affect housing demand, which is determined by housing preferences and ability of residents to pay for their preferred type of housing (Table 4-34).

The only additional housing demand in Moffat County would be for single family dwellings. Demand would increase at an annual rate of 6.9 percent between 1977 and 1990.

In Rio Blanco County, 76 percent of additional demand for housing by 1980 at mid-level would be for mobile homes. To meet this demand, availability of mobile homes would have to increase at an annual rate of 33 percent between 1977 and 1980. By 1990, about 97 percent of the additional demand for housing would be for single family dwellings. Availability of single family units would have to grow at an annual rate of 8.3 percent between 1977 and 1990 to meet this demand.

All of the additional demand for housing in Routt County by 1980 and over 80 percent by 1985 and 1990 would be for single family dwellings. Between 1977 and 1990 availability of single family units would have to increase by 7.0 percent annually in order to meet this demand.

There would be more units in the current housing stock in Moffat and Routt Counties through 1980 than would be needed to accommodate the population at mid-level. In Moffat County, the excess of units would be due to the expected population decline. The excess in Routt County would be due to the number of second homes in the housing stock that are not generally available for year-round rent. After 1980, expansion of the housing supply would be needed in Moffat and Routt Counties, to accommodate normal growth as well as to meet new demand attributable to development of additional federal coal at mid-level. Expansion of the housing supply in Rio Blanco County would be needed continuously through 1990.

Some residents in the three-county area would be unable to live in their preferred housing type at a cost they could afford unless availability of housing were to exceed projected levels of demand. However, residents in Routt County who would prefer mobile homes would likely be able to buy them because recent increases in the availability of mobile homes there is exceeding the projected rate of demand for them called for at mid-level.

Education

Projected school district enrollments at mid-level are presented in Table 4-35. Following is a discussion of the implications of projected increases for each school district.

TABLE 4-34

ADDITIONAL HOUSING DEMAND AT CUMULATIVE DEVELOPMENT AT MID-LEVEL

County	1977 housing units 1/	Additional housing demanded by type of unit 2/ 1980 Number	1980 Percent of total(%)	1980 Average annual growth rate 1977-1980(%)	1985 Number	1985 Percent of total(%)	1985 Average annual growth rate 1977-1985(%)	1990 Number	1990 Percent of total(%)	1990 Average annual growth rate 1977-1990(%)
Moffat										
Single family	2,069	657	100.0	9.6	1,588	100.0	7.4	2,834	100.0	6.9
Multiple family	584	0	0	0	0	0	0	0	0	0
Mobile homes & other	1,125	0	0	0	0	0	0	0	0	0
Total units	3,778	657	100.0	5.5	1,588	100.0	4.5	2,834	100.0	4.4
Rio Blanco										
Single family	1,621	145	24.0	2.9	1,842	58.4	10.0	2,935	96.5	8.3
Multiple family	225	0	0	0	299	9.5	11.2	105	3.5	3.0
Mobile homes & other	340	459	76.0	33.0	1,012	32.1	18.8	0	0	0
Total units	2,186	604	100.0	8.5	3,158	100.0	11.8	3,040	100.0	6.9
Routt										
Single family	2,851	658	100.0	7.2	1,857	81.0	6.5	4,051	82.8	7.0
Multiple family	2,132	0	0	0	0	0	0	0	0	0
Mobile homes & other	715	0	0	0	437	19.0	6.1	844	17.2	6.2
Total units	5,698	658	100.0	3.7	2,294	100.0	4.3	4,895	100.0	4.9

1/ Estimates based upon State of Colorado, Division of Housing, Housing in Colorado: Estimates of Housing Inventory and Household Characteristics for January 1, 1977 and Projections of Household Growth to January 1, 1982. March, 1978.

2/ Housing "demand" is the response to a question "What type of housing would you be willing and able to move into if it were available?"

Source: Based on Construction Worker Profile, Summary Report, December, 1975.

TABLE 4-35

SCHOOL DISTRICT POPULATION AND ENROLLMENT PROJECTIONS FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL

County School district	1977				1980				1985				1990			
	Population	Elementary	Secondary	Total	Population	Elementary	Secondary	Total	Population	Elementary	Secondary	Total	Population	Elementary	Secondary	Total
Moffat																
Craig - RE #1	10,313	1,323	1,141	2,464	9,143	1,135	974	2,109	13,960	1,911	1,663	3,574	17,651	2,505	2,191	4,696
Rio Blanco																
Meeker - RE #1	1,848	385	342	727	4,531	817	726	1,543	9,421	1,604	1,425	3,029	8,731	1,493	1,326	2,819
Rangley - RE #4	1,871	283	334	617	2,057	313	361	674	4,657	731	733	1,464	4,392	688	695	1,383
Routt																
Hayden - RE #1	1,362	280	228	508	1,964	377	314	691	3,929	693	595	1,288	6,007	1,028	892	1,920
Steamboat Springs - RE #2	4,028	737	681	1,418	5,091	908	833	1,741	8,985	1,535	1,390	2,925	12,152	2,045	1,843	3,888
South Routt - RE #3	1,063	286	197	483	1,078	288	199	487	2,065	447	340	787	2,845	573	452	1,025

Moffat - Craig. The Craig District would expect enrollment to drop from the current 2,464 to 2,109 in 1980 (a 14.4 percent decrease) and then increase to 3,574 between 1980 and 1985, and to 4,696 by 1990. Projected school district capacity would be able to absorb increases until about 1985-86. By 1990, projected total enrollment would reach 4,696. Of this, 2,345 would be due to additional development of federal coal. This would be 916 over projected capacity. To meet this need, one elementary and one junior high school would suffice. The currently planned new high school which will have a capacity of 900, would be ample for expected high school enrollment increases through 1990. Staffing requirements to meet mid-level enrollment would be the elimination of 18 teaching positions between 1977 and 1980, the hiring of 74 new teachers between 1980 and 1985, and the hiring of 57 additional teachers between 1985 and 1990.

Rio Blanco - Meeker. Enrollment would increase sharply and steadily between now and 1985 (from the current 727 to 1,543 in 1980 and to 3,029 in 1985), dropping back to 2,819 between 1985 and 1990. Of the net increase, 14.8 percent would be due to additional development of federal coal.

Space for an additional 113 students would be necessary by 1980, and for an additional 1,486 students by 1985, when enrollments are projected to peak. An adequate building program to meet these increases would involve two new elementary schools and one new junior high school, each with a minimum capacity of 500. Construction of these facilities would have to be completed between 1980 and 1984, with one new elementary school ready for the 1981-82 academic year. Staffing increases necessary at mid-level would be 44 new teachers by 1980 and 80 additional teachers between 1980 and 1985. Between 1985 and 1990, eleven of these positions would no longer be necessary, due to enrollment decreases.

Rio Blanco - Rangely. The Rangley School District, with a current enrollment of 617, could expect increases totaling 674 by 1980 and 1,464 between 1980 and 1985, with a decrease of about 100 pupils between 1985 and 1990. Nineteen percent of the enrollment increases occurring between 1977 and 1985 would be attributable to additional development of federal coal.

Projected school district capacity would be sufficient until the 1982-83 school year. Thereafter, additional space requirements would necessitate 194 pupil spaces by 1985, 82 of which would no longer be necessary by 1990. The bulk of these increases could be absorbed through the use of modular classrooms, particularly given the downturn projected after 1985. Thus, additional permanent elementary space for roughly 100 students (4-5 additional classrooms) would be adequate to meet projected mid-level enrollment increases.

In order to maintain current pupil-teacher ratios, 3 new teachers would be needed between 1977 and 1980 and 56 additional teachers between 1980 and 1985. Between 1985 and 1990, six of these positions would no longer be necessary, due to enrollment decreases.

Routt - Hayden. According to Table 4-30, the Hayden School District would experience a steadily climb from a current enrollment of 507 to 1,920 by 1990. Of this increase, 65.4 percent would be attributable to additional development of federal coal.

Projected school district capacity would be able to meet growth until about 1986-87, when additional space for 300 students would be required. Projected junior-senior high school space is adequate to meet demand through 1990, but additional space would be needed for about 300 students.

In order to maintain current student/teacher ratios, 13 new teachers would be needed by 1980, 42 additional teachers between 1980 and 1985, and 45 additional teachers between 1985 and 1990.

Routt-Steamboat Springs. Steamboat Springs would experience significant enrollment increases between 1977 and 1990. From the current 1,417, enrollment would be expected to increase to 1,741 by 1980, 2,925 by 1985, and 3,888 by 1990. Fifty-six percent of this increase would be due to additional development of federal coal.

Current projected school district capacity would be exceeded by 1980. Potential capacity of the existing buildings, with additions, would, if utilized, suffice until about 1983. Additional space for 689 pupils would be necessary by 1985, and for another 969 between 1985 and 1990. Of this, elementary space would account for approximately 900 students, secondary space for roughly 700.

To maintain current pupil/teacher ratios, 18 new teachers would be needed by 1980, 65 additional teachers between 1980 and 1985, and 53 additional teachers between 1985 and 1990.

Routt-South Routt. Projected enrollment in the South Routt School District would remain stable through 1980, when it would begin a gradual climb to 787 by 1985, and to 1,025 by 1990. Eighty percent of this increase would be due to additional development of federal coal.

Projected school district capacity would be able to handle projected mid-level increases until 1987-88, when additional space for 120 students would be necessary. Projected elementary and high school space would be adequate to meet these increases; increased space would be needed for junior high.

To maintain current pupil/teacher ratios, no staff increases would be needed between 1977 and 1980, 19 new teachers between 1980 and 1985, and 16 additional teachers between 1985 and 1990.

Health Care Services

Need for hospital beds are addressed on a region-wide basis. Taking into consideration the capacity of existing hospital facilities and the current expansion of one of the hospitals, the region would face a deficit of 42 hospital beds by 1990 (all due to additional development of federal coal), unless average bed utilization ratios were to increase, in which case fewer hospital beds would be needed.

Table 4-36 projects the number of physicians and registered nurses needed in each county at mid-level to provide adequate health care to the population. Routt County, which currently has the most favorable population-to-physican ratio, would need to recruit three additional doctors and 44 additional registered nurses by 1990 (all doctors and two of the registered nurses would be due to additional development of federal coal). Moffat County would need five additional doctors by 1990 (four due to additional development of federal coal) and 36 registeres nurses (27 due to additional federal coal). Rio Blanco County would need three additional doctors, (two due to additional federal coal), and 25 additional registered nurses (six due to additional federal coal). Because of the expected population decline in Rio Blanco County between 1985 and 1990, one more doctor and three more registered nurses would be needed in 1985 than in 1990.

Some difficulty might be experienced in recruiting new physicians and registered nurses in the three counties. None has a major medical facility. Moffat and Rio Blanco Counties might have more difficulty in recruiting additional health care specialists than Routt County because neither has a recreation development such as the ski resort.

Local Government Finances

Revenue and Expenditure Projections. Table 4-37 compares projected operating expenditures with revenues which would accrue to individual communities in the study area at mid-level. The Moffat and Routt County governments would experience significant revenue surpluses due to greatly increased property tax assessments. It is not known whether they would use these surpluses to increase their financial reserves, expand the range and level of services offered to county residents, or reduce local tax rates. Either of the latter two alternatives would result in a reduction of the projected revenue surpluses. The advent of a possible regional tax-sharing system such as that discussed in Chapter 2 would also reduce potential county surpluses by diverting a portion of county tax monies to municipal governments.

While Rio Blanco County is shown facing a potential operating deficit, revenues projections for Rio Blanco do not incorporate property taxes on future investments in shale oil facilities

TABLE 4-36

NEED FOR HEALTH CARE SPECIALISTS FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL

County	Current number 1/	1980 Total need	1980 Additional need	1985 Total need	1985 Additional need	1990 Total need	1990 Additional need
Moffat							
Physicians	4	5	1	7	3	9	5
Registered nurses	26	32	6	49	23	62	36
Rio Blanco							
Physicians	4	4	0	8	4	7	3
Registered nurses	26	28	2	54	28	51	25
Routt							
Physicians	8	6	0	10	2	11	3
Registered nurses	34	43	9	67	33	78	44

1/ 1976 figures for physicians; 1972 figures for registered nurses.

Source: Based on a population to physician ratio of 1:2,000 and a population to registered nurse ratio of 1:285.

TABLE 4-37

PROJECTED GRANTS/REVENUES AND EXPENDITURES FOR CUMULATIVE DEVELOPMENT AT MID-LEVEL

	1980			1985			1990		
	Revenues	Expenditures	Surplus/deficit overrun/(short fall)	Revenues	Expenditures	Surplus/deficit overrun/(short fall)	Revenues	Expenditures	Surplus/deficit overrun/(short fall)
Counties									
Moffat	$3,874,232	$1,536,664	$2,337,568	$5,178,700	$2,346,257	$2,832,443	$6,302,642	$2,967,107	$3,335,535
Rio Blanco	1,734,758	1,958,700	1/	2,226,049	3,802,862	1/	2,547,366	3,569,853	1/
Routt	2,829,078	2,189,232	639,846	4,117,173	3,415,569	701,604	5,829,783	3,987,421	1,842,362
Cities									
Craig	1,723,180	1,677,255	45,925	2,800,036	3,104,572	(304,536)	3,785,588	4,247,251	(461,663)
Dinosaur	61,616	36,874	24,742	100,150	52,000	48,150	129,542	47,749	81,793
Meeker	1,094,245	668,639	425,606	2,265,810	1,389,314	876,496	2,410,593	1,390,256	1,020,337
Rangely	1,051,265	415,514	635,751	2,079,585	940,714	1,138,871	2,344,043	887,184	1,456,859
Hayden	394,779	218,513	176,266	802,796	496,625	306,171	1,372,050	759,284	612,766
Oak Creek	134,578	82,521	52,057	276,436	192,440	83,996	430,040	281,302	148,738
Steamboat Springs	2,890,649	2,236,428	654,221	4,358,123	3,947,020	411,103	6,237,714	5,338,252	899,462

1/ Rio Blanco's oil shale revenue has not been included since local authorities have not developed a formula for assessing this mineral. Local authorities state that existing formulas for property assessments would grossly misrepresent the assessed valuation. (Mr. Bloomfield, Rio Blanco County Assessor, telephone conversation, July 24, 1978).

(see note to Table 4-37). In view of the magnitude of these investments (over $2 billion by 1990), it is certain that Rio Blanco County's long-term operating position would be favorable. However, the projected deficit in 1980 is an indication that Rio Blanco County faces potential front-end financing problems. The latter are likely to result where the county must provide services to thousands of shale oil plant construction workers before property tax revenues begin to flow from the completed plants.

Craig would experience long-term operating shortfalls at mid-level. Craig's 1985 shortfall would be almost $304,536 and would increase to $461,663 in 1990.

The prospect of long-term operating shortfalls in Craig would require adjustment of its overall fiscal structure. Such a structural solution might involve levying new local taxes, implementing a tax sharing plan with other regional governments, curtailing non-essential expenditures, or some combination thereof.

Incremental Property and Sales Tax Revenues. Tables 4-38, 4-39, and 4-40 highlight the major impacts of mid-level development on local government finances. Table 4-38 describes the increase in non-residential assessed valuation expected to occur at mid-level as a result of new coal-related investments. Tables 4-39, 4-40, and 4-41 relates these changes to trends in total assessed valuation, including increased residential assessments due to mine-related population increases. Table 4-42 indicates increases in sales tax collections.

Capital Funds Requirements. The preceding portion of this discussion has focused on local communities' projected requirements for operating funds at mid-level development. Table 4-43, which is based on projected capital facilities requirements (see the discussion of local services) and estimated facilities costs, contains estimates of these communities' requirements for capital funds between 1977 and 1990.

Most communities should be able to raise the required funds internally, i.e., out of projected operating surpluses or by bond sales. Probable exceptions include Meeker and Steamboat Springs, which face projected total capital expenditures of $9.0 million and $19.7 million, respectively, during 1977-1990. Possible sources of financial assistance for these projects include the Colorado General Assembly's project grants for emergency situations relating to sewage treatment, project grants under the Federal Water Pollution Control Act, and grants or loans from the U.S. Commerce Department Economic Development Administration.

Impact on Colorado State Finances. The total impact on state finances cannot be identified due to the limitations of the model used in this analysis. However, it is possible to identify specific increases from sales taxes and mineral royalities and state income tax paid by employees.

TABLE 4-38

PROJECTED INCREASES IN NON-RESIDENTIAL
ASSESSED VALUATION DUE TO NEW INVESTMENTS IN COAL AND
RELATED PRODUCTION INCREASES AT MID-LEVEL

Additional coal mining at mid-level	Cumulative increases 1978-80	1978-85	1978-90
Facilities			
Moffat	$ 360,000	$ 840,000	$1,500,000
Routt	3,600,000	9,150,000	9,900,000
Production			
Moffat	1,874,250	1,972,000	1,927,000
Routt	1,252,000	1,961,925	2,072,000

In the benchmark years of 1980, 1985, and 1990, the state would receive $24,467,846, $34,677,455, and $36,732,601, respectively, from these sources. Additional revenue would be received with additional development of federal coal at mid-level - an estimated $16,502,096, $20,418,526, and $24,636,345, respectively, for the three benchmark years.

Utilities

Purchase of electricity from companies outside the region would be necessary if demand for electricity within northwest Colorado were to exceed the power-generating capacity of the electricity suppliers, the Moon Lake Electric Association and the Colorado-Ute Electric Association, the latter of which supplies power to the Yampa Valley and White River Electric Associations.

Increased pipeline capacity for natural gas would be necessary to meet mid-level population needs. In the short run, facility constraints would create distribution problems for natural gas companies because current demand for natural gas is almost at pipeline capacity and two or three years would be necessary for pipeline capacity to be increased. There would, however, be adequate lead time to increase pipeline capacity to meet projected mid-level population needs by 1985 and 1990. In addition to increasing pipeline capacity, additional natural gas reserves would also be needed.

TABLE 4-39

CUMULATIVE CHANGES IN ASSESSED VALUATION AND RESULTANT PROPERTY TAX REVENUES AT MID-LEVEL
1980

	1977 assessments		Change since 1977		Total		Mill levy		Property tax revenues
Moffat	60,246,860	+	12,811,500	=	73,058,360	X	15	=	1,143,363
Craig	14,968,190	+	6,790,095	=	21,758,285	X	16	=	348,132
Dinosaur	299,800	+	640,575	=	940,375	X	12	=	11,284
Rio Blanco	201,564,840	+	5,581,500	=	207,140,000	X	5.5	=	1,139,304
Meeker	5,870,240	+	3,181,455	=	9,051,695	X	8.8	=	79,656
Rangely	4,080,090	+	1,395,375	=	5,475,465	X	24	=	135,901
Routt	103,235,320	+	12,831,000	=	116,060,000	X	15.74	=	1,826,883
Hayden	2,389,880	+	1,924,650	=	4,314,530	X	26.05	=	113,177
Oak Creek	1,232,310	+	513,240	=	1,745,550	X	24	=	41,853
Steamboat Springs	34,299,300	+	5,260,710	=	39,560,010	X	8.28	=	327,556

TABLE 4-40

CUMULATIVE CHANGES IN ASSESSED VALUATION AND RESULTANT PROPERTY TAX REVENUES AT MID-LEVEL
1985

	1977 assessments		Change since 1977		Total		Mill levy		Property tax revenues
Moffat	60,246,860	+	43,777,500	=	104,020,000	X	15.65	=	1,627,981
Craig	14,968,190	+	23,202,075	=	38,170,265	X	16	=	610,724
Dinosaur	299,800	+	2,188,875	=	2,488,675	X	12	=	29,864
Rio Blanco	201,564,840	+	47,572,500	=	249,130,000	X	5.5	=	1,370,250
Meeker	5,870,240	+	27,116,325	=	32,986,565	X	8.8	=	290,281
Rangely	4,080,090	+	11,893,125	=	15,973,215	X	24.82	=	396,455
Routt	103,235,320	+	57,782,500	=	161,010,000	X	15.14	=	2,534,420
Hayden	2,389,880	+	8,667,375	=	11,057,255	X	26.05	=	287,488
Oak Creek	1,232,310	+	2,311,300	=	3,543,610	X	24	=	85,046
Steamboat Springs	34,299,300	+	23,690,825	=	57,990,125	X	8.28	=	480,158

TABLE 4-41

CUMULATIVE CHANGES IN ASSESSED VALUATION AND RESULTANT PROPERTY TAX REVENUES AT MID-LEVEL
1990

	1977 assessments		Change since 1977		Total		Mill levy		Property tax revenues
Moffat	60,246,860	+	99,040,500	=	159,280,000	X	15.65	=	2,492,847
Craig	14,968,190	+	52,491,465	=	67,459,655	X	16	=	1,079,354
Dinosaur	299,800	+	4,952,025	=	5,251,825	X	12	=	63,021
Rio Blanco	201,564,840	+	105,620,000	=	307,180,000	X	5.5	=	1,689,516
Meeker	5,870,240	+	60,203,400	=	66,073,640	X	8.8	=	581,448
Rangely	4,080,090	+	26,405,000	=	30,485,090	X	24.82	=	756,639
Routt	103,235,320	+	141,840,000	=	245,070,000	X	15.74	=	3,857,485
Hayden	2,389,880	+	21,276,000	=	23,665,880	X	26.05	=	616,496
Oak Creek	1,232,310	+	5,573,600	=	6,905,910	X	24	=	155,741
Steamboat Springs	34,299,300	+	58,154,400	=	92,453,700	X	8.28	=	765,516

TABLE 4-42

MID-LEVEL SCENARIO: PROJECTED RETAIL SALES TAX REVENUES (thousands of dollars)

County City	1980	1985	1990
Moffat	$1,494	$1,951	$2,152
Craig	766	1,062	1,164
Dinosaur	9	12	13
Rio Blanco 1/			
Meeker	316	523	483
Rangely	607	1,005	929
Routt 1/			
Hayden	82	114	142
Oak Creek	19	27	34
Steamboat Springs	997	1,114	1,734

1/ Rio Blanco and Routt Counties do not levy a sales tax.

TABLE 4-43

CAPITAL NEEDS AND COST AT CUMULATIVE DEVELOPMENT AT MID-LEVEL (thousands of dollars)

	Activity		
City	Fire trucks	Water systems	Sewer facilities
Craig	75	-	-
Meeker	150	-	8,888
Rangely	75	-	-
Hayden		76	2,020
Oak Creek	75	-	549
Steamboat Springs	225	4,104	15,352
Yampa	75	-	-

Transportation Networks

Impact on transportation networks would be caused by (1) transportation of coal out of the study area, and (2) increased employment and population, with its attendent increase in vehicles and miles-traveled.

Highways

Based on population projections for Routt, Moffat and Rio Blanco counties and a factor of 1.24 vehicles per person (Transportation, Chapter 4, NWCCRES) vehicle registrations for mid-level development would be 37,700 in 1980, 60,300 in 1985, and 67,500 in 1990. Vehicle registrations attributable to additional development of federal coal would be 4,600 in 1980, 13,800 in 1985, and 19,000 in 1990. Table 4-44 presents the incremental increases in average daily traffic volumes that would result from the mid-level scenario at selected points in the study region. There was an average of 525,000 vehicle-miles traveled in the study area in 1976. By 1980 there would be 874,000, by 1985, 971,000, and by 1990, 1,100,000. The vehicle-miles due to additional development of federal coal at mid-level would be 304,000 by 1980, 345,000 by 1985, and 415,000 by 1990. Traffic volume increases at mid-level would also result in more accidents, by 1980, 2,450 accidents per year in the study area, 2,700 by 1985, and 3,000 by 1990. Accidents attributable to additional development of federal coal would be 360 by 1980, 400 by 1985, and 490 by 1990. Increased vehicular traffic would also result in higher annual maintenance costs. At this time, no rerouting of any state highways is planned to accommodate mining activities. A limited number of minor graded dirt roads and gravel roads lie within mining areas, but they are generally lightly traveled and could be rerouted if necessary without much disturbance to traffic.

A marked increase in loaded diesel coal truck traffic could occur in the study area. Most highways in the region were designed for light traffic and although paved, would deteriorate rapidly if repeatedly used by heavy coal trucks of 25 to 30 net tons per load. Because of increases in heavy truck traffic as well as regular traffic, roads would require more maintenance at a higher cost. Two roads that would suffer greatest deterioration would be State Highway 13 between Axial and Meeker and State Highway 394 from U.S. 40 to the coal rail loading site just south of Craig. Meeker, Craig, Hayden, and Steamboat Springs would all share in the impacts of increased vehicular traffic, both from heavy trucks and passenger vehicles. Tables 1-3, 1-4, 1-5, and 1-6, Chapter 1, indicate cumulative coal-related impacts at the mid-level and portions of those impacts attributable to additional development of federal coal. Including coal exploration trails, access roads, and haulage roads, there would be 30 miles of new road by 1980, 80 miles by 1985, and 130 miles by 1990 (Table 1-5). This would permanently disturb 630 acres by 1980, 1,680 by 1985, and 2,730 acres by 1990 (Table 1-6). New road attributable to additional development of federal coal would be 20 miles by 1980, 50 miles by 1985, and 75 miles by 1990 (Table 1-3). This would

TABLE 4-44

INCREASES IN TRAFFIC VOLUMES OVER 1976 LEVELS AT SELECTED POINTS IN THE STUDY AREA DUE TO MID-LEVEL DEVELOPMENT 1/ (UNITS: AVERAGE DAILY TRAFFIC)

Highway	Location 2/	1980	1985	1990
US 40	at Utah State Line	650	550	800
US 40	W/o Dinosaur	800	650	950
US 40	E/o Dinosaur	650	550	750
US 40	E/o Rd to Blue Mtn	550	500	650
US 40	N/o Jct SH 318	650	500	750
US 40	E/o Jct SH 318	750	600	850
US 40	W/o W Jct SH 13	2,000	1,600	2,200
US 40	E/o W Jct SH 13	3,700	3,100	4,200
US 40	W/o E Jct SH 13	7,900	6,700	9,500
US 40	E/o E Jct SH 13	4,000	3,350	4,650
US 40	W/o Hayden	400	450	500
US 40	E/o Hayden	250	450	550
US 40	W/o Milner	350	350	450
US 40	W.C.L. Steamboat Springs	800	850	1,050
US 40	S.C.L. Steamboat Springs	1,200	1,300	1,600
US 40	5 Mi S/o Jct 131	250	300	350
SH 131	S/o Jct US 40	150	200	200
SH 131	N/o Oak Creek	100	110	120
SH 131	N/o Phippsburg	150	150	150
SH 131	S/o Phippsburg	100	100	130
SH 131	S/o Yampa	80	80	100
SH 13	Colorado-Wyoming Stateline	850	750	1,050
SH 13	N.C.L. Craig	1,000	850	1,250
SH 13	S/o US 40	2,650	2,200	3,050
SH 13	N/o Hamilton	1,700	1,400	1,850
SH 13	S/o Hamilton	1,700	1,400	1,850
SH 13	at Rio Blanco-Moffat Co. Line	1,450	1,200	1,550
SH 13	E.C.L. Meeker	1,550	3,150	3,150
SH 13	E/o Jct SH 64	1,400	2,850	2,850
SH 13	S/o Jct SH 64	1,200	2,400	2,450
SH 317	E/o Jct SH 13	80	60	90
SH 394	S.C.L. Craig	3,150	2,850	4,200
SH 394	2 Mi S/o Craig	1,450	1,250	1,850
SH 64	W/o Jct SH 13	900	1,800	1,800
SH 64	4 Mi W/o Jct SH 13	800	1,600	1,600
SH 64	E/o Jct SH 139	1,250	2,450	2,450
SH 64	W/o Jct SH 139	1,350	2,700	2,700
SH 64	W.C.L. Rangely	1,500	3,000	3,050
SH 64	W/o Blue Mt. Rd	1,250	2,400	2,400
SH 64	E/o Bonanza Rd	850	1,700	1,700
SH 64	at Rio Blanco-Moffat Co. Line	850	1,700	1,700
SH 139	S/o SH 64	300	580	650

1/ Over and above low-level, Chapter 8, Table 8-43.
2/ Key to abbreviations:

SH: State Highway
N/o: North of
S/o: South of
E/o: East of
W/o: West of
N.C.L.: North City Limits
S.C.L.: South City Limits
E.C.L.: East City Limits
W.C.L.: West City Limits

permanently disturb 420 acres by 1980, 1,050 acres by 1985, and 1,575 acres by 1990 (Table 1-4).

Railroads

Coal transported from the region would move by rail. Coal related rail traffic would increase from 105,120 carloads currently to 226,400 carloads in 1990. The larger mining operations would most likely ship by unit train in user owned cars. While the smaller mining operations would likely ship in multicar shipments, it is assumed that these shipments would be assembled into a train similar in length to a unit train for the main-line haul from the region. With an average train length of 80 cars, the probable level of development in the region would generate 2,830 unit train round trips (5,660 train trips) annually in 1990. This would be an average of 7.75 unit train roundtrips per day. Improvements to the D&RGW mainline to permit efficient operation of 100-car unit trains would reduce this volume to an average of 6.2 daily unit train roundtrips. It is assumed that all coal would be moving to destinations east of the region.

The principal railroad construction impacts that would occur as a result of this alternative would be related to the construction of the 12.5 mile rail spur to Peabody's Moffat mine. In addition coal loading at new mine sites would require construction of small lengths of spur track and loading facilities. No other major modifications to the rail system in the region would be necessary to accommodate the amount of traffic generated by the most probable level of production.

The amount of fuel consumed by rail transporting coal from the northwest Colorado region would be dependent on many factors, some presently unknown. The ultimate coal markets, train routing, and type of rail carriage (unit train or general freight) would influence the total amount of fuel consumed. To assist in understanding this impact, the amount of fuel consumed per 100 miles of trip was estimated assuming a total annual haul of 22.64 million tons and a net fuel efficiency of 300 net ton-miles/gallon (typical for unit trains). Under these conditions, 7.55 million gallons of diesel fuel would be consumed annually per 100 miles of shipment.

Primary sources of air pollution associated with coal train movements are pollutants emitted as part of diesel exhaust and dust blown from uncovered coal cars. The three primary locomotive emissions are carbon monxide, hydrocarbons, and nitrogen oxides.

Greater train traffic would result in an increase in noise along the rail line. The area in which noise levels exceed the Environmental Protection Agencies long-term noise control goal (55 dBA) would expand. Because of new locomotive and car single-exposure noise level standards, new equipment will run quieter and therefore reduce noise in future rail operations.

As a result of both increased train and auto traffic, the incidence of auto-train collisions at unseparated grade crossings would increase. The cumulative hazard ratings for crossings in the study area are 8.13 for 1976, 8.21 by 1980, 8.30 by 1985, and 8.40 by 1990. The increase in hazard ratings due to additional development of federal coal are 2.87 by 1980, 3.60 by 1985, and 4.60 by 1990. Hazard ratings are the number of auto-train collisions expected in a 5-year period.

As a result of increased train traffic, the average daily vehicle waiting time at unseparated grade crossings would increase. Assuming a 3-minute delay per train, daily vehicle waiting time at mid-level would increase from the present 12 minutes per day to 17 minutes per day by 1980, 23 minutes by 1985, and 23 minutes by 1990. Delays attributable to additional development of federal coal would be 3 minutes by 1980, 8 minutes by 1985, and 10 minutes by 1990. This would be especially significant to emergency vehicles, which would have no alternate route. The impact to emergency services is difficult to quantify because there is no data on the probability of an emergency vehicle being delayed in the study area.

Impacts resulting from rail operations would not be confined to the study area; they would be manifested, to some degree, wherever the coal shipment goes. The major extra-regional implications of the movement of northwest Colorado coal would come where these movements would be added to lines with already high volumes of rail traffic.

It is assumed that coal produced in the region would travel east to Denver. At the probable level of production, the West Central Colorado Region would generate an average movement of 5½ trains (of 100 cars) per day between that region and the front range of the Rockies. The Central Utah region could generate up to an average of 13½ unit trains (of 100 cars) per day. The future markets, and therefore the routing of the Utah coal, is unknown. If it were all to go east, there would be an average of 19 trains of coal per day from west of Dotsero moving over the D&RGW to the front range. Should this traffic move over the Tennesee Pass between Dotsero and Pueblo, 38 train trips daily would be necessary.

There is presently sufficient surplus capacity in the D&RGW east-west main-lines to handle the coal traffic from the three regions in addition to existing traffic. If these levels would be reached, however, the improvements to the Dotsero to Denver line previously mentioned would be necessary to permit efficient operation of 100 car trains as well as providing sufficient capacity to handle any substantial growth in the movement of general freight traffic which may occur.

If the two coal regions west of the northwest Colorado study area were to reach a high-level development, their coal and coal from central Utah would all travel east to market. Because of this, there would be little room for general traffic growth without additional major modifications to the main-lines, which have traffic volumes in the range of 40 trains per day.

D&RGW has indicated that it would make improvements necessary to handle growth in traffic.

The preceding discussion assumed that all coal produced in central Utah would be shipped from the region by rail in one direction. This is unlikely. There are presently three coal-fired power plants in central Utah (two of which are expanding) which would be probable local markets for large quantities of coal. In addition, there are alternative transporatation plans under discussion as well as tentative contracts for coal shipments both east and west from the region.

The growth of coal traffic, in particular the traffic moving between Wyoming and Texas in a north-south direction, has begun to create rail-community conflicts on the front range. These problems are most pronounced in the Fort Collins to Colorado Springs area, which includes Denver. Routing of northwest Colorado coal through Moffat Tunnel to an interchange with another carrier in Denver, although not seriously affecting north-south movements, would add to already high rail congestion in the city. If this traffic then moves south to Colorado Springs or Pueblo for interchange, it would further aggrevate existing problems. Table 4-45 presents the number of grade crossings encountered between Denver and Pueblo.

TABLE 4-45

HIGHWAY CROSSINGS OF RAIL LINE 1/
DENVER TO PUEBLO

Community	Population	Crossing of Rail Line	
		At Grade	Grade Separated
Englewood	36,500	5	1
Littleton	34,000	3	0
Castle Rock	2,500	3	0
Colorado Spgs.	185,000	9	8
Pueblo 2/		1	1

1/ Source: Coal Train Assessment, URS for the Colorado Department of Highways, December 1976.
2/ That portion of the city above the eastbound AT&SF tracks.

These rail lines, jointly operated D&RGW & AT&SF, generally pass through the center of these communities. Except in Colorado Springs and Pueblo, little opportunity is afforded to cross the tracks when a train

is present. This disrupts the established traffic circulation patterns and effectively separates many essential community facilities from their service areas. The Coal Train Assessment performed for the Colorado Department of Highways has recommended study of eleven proposed new grade-separated crossings.

This line provides the only rail connection on the front range between Denver and Pueblo and is used by the AT&SF to serve Denver and the BN to ship coal to Texas. Large volumes of northwest Colorado coal using this line may require installation of more passing tracks on the segments with only a single track or the double tracking of these segments.

Shipment of coal over the Dotsero to Pueblo line would not create significant problems regarding delay of traffic. If significant traffic would not develop from the West Central Colorado and Central Utah regions, coal from northwest Colorado could be routed over this line to Pueblo and Colorado Springs. However, a new connection between the main-lines at Dotsero would have to be constructed, trains would be limited to about 50 cars in length, and the trip to Pueblo would be about 11 miles longer.

There are seven rail routes which could take coal traffic to potential markets to the east or southeast once it reaches the front range. If all the coal traffic generated in the three regions were to be routed over one or two of these lines, major improvements would be necessary to provide the needed capacity. However, if the traffic is divided among the various lines, no individual line's capacity would be seriously taxed, and the impact at any particular point downline from additional train operations would be less than would occur at points in the region.

SUMMARY OF ENVIRONMENTAL IMPACTS

Following is Table 4-45, which summarizes the impacts of additional federal coal development at mid-level for 1980, 1985, and 1990.

TABLE 4-45

SUMMARY TABLE OF IMPACTS 1/

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Geologic Setting Topography	Temporary disturbance of 5,160 acres by 1980 due to stripping of surface for coal mining. Of this, 470 acres due to additional federal coal.	Temporary disturbance of an additional 7,310 acres by 1985. Of this, 2,030 acres due to additional federal coal.	Temporary disturbance of an additional 7,330 acres by 1990. Of this, 2,500 is due to additional federal coal.
	Permanent disturbance due to long-term development like mine buildings and shop facilities, railroads, and housing developments: 2,740 acres by 1980. Of this, 1,140 acres due to additional federal coal.	Permanent disturbance of an additional 4,500 acres by 1985. Of this, 2,315 acres due to additional federal coal.	Permanent disturbance of an additional 6,730 acres by 1990. Of this, 955 acres due to additional federal coal.
	Small amount of subsidence over underground mine; not quantifiable. No existing roadways or structures threatened.	See 1980.	See 1980.
Paleontology	Loss of plant, invertebrate, and vertebrate fossil material due to mining, unauthorized collecting and vandalism.	See 1980.	See 1980.
	Exposure of fossil materials for scientific examination and collection. Not quantifiable.	See 1980.	See 1980.
	Location of loss: 5 to 10 miles west, 10 miles northeast, and 5 to 10 miles south of Craig, Colorado.	See 1980.	See 1980.
Mineral Resources	Removal of 20.3 million tons of coal per year by 1980. Of this, 3.7 million tons per year due to additional federal coal.	Removal of 27.5 million tons per year by 1985. Of this, 9.3 million tons per year would be additional federal coal.	Removal of 28.3 million tons per year by 1990. Of this, 12.4 million tons per year due to additional federal coal.
	Recovery ratio: 50% by underground, 90% by surface mining. After mining ceases, 130 million tons of unrecovered coal.	See 1980.	See 1980.
	Conflicts between oil and gas and coal: sequential recovery makes impacts small, but not quantifiable. Conflicts with coal vs. uranium unlikely.	See 1980.	See 1980.
Water Resources	Probable loss of a few springs.	See 1980.	See 1980.
	Dissolved solids concentrations in Colorado River below Hoover Dam increases by 1.1 mg/l, 0.1 mg/l due to additional federal coal; would be significant.	Dissolved solids increase below Hoover Dam - 6.9 mg/l; 0.5 due to additional federal coal; significant.	Dissolved solids increase below Hoover Dam - 7.6 mg/l; 0.6 mg/l due to additional federal coal; significant.
Climate	Additional development of federal coal would not significantly modify climate and meterology of the study area. Temporary loss of vegetation in mining areas may increase storms during the late spring and early summer, but, this effect would be extremely localized. Redistribution of soils and other materials at mines, railroad and transmission lines could result in local changes in wind speeds and direction, temperatures, and relative humidity.	See 1980.	See 1980.
Air Quality	Regional impact of total suspended particulates (TSP) would be small; within a mile of Craig, annual TSP levels would rise 5 ug/m^3, less around other towns by 1990. Annual average increase of TSP along roads and near mines also small.	See 1980.	See 1980.

1/ Only significant impacts are listed.

TABLE 4-45 (Cont.)

SUMMARY TABLE OF IMPACTS 1/

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Air Quality (Cont.)	Maximum annual TSP concentrations would increase around the Trapper Mine.	TSP concentrations would reach 50 ug/m^3, exceeding the Colorado standard of 45 ug/m^3.	Annual TSP concentrations would reach 45 ug/m^3 within 1 mile of Steamboat Springs. Levels close to mining activities would exceed state and federal standards, but rapid settling of particulates should prevent region-wide violations of air quality standards: levels would drop to 40-50 ug/m^3 at 1 mile from larger mines.
	Craig Power Plant Unit 3 would increase SO_2 levels up to 3 miles downwind, but this would not exceed 3-hour and 24-hour Class II PSD standards. SO_2 standards in Class I (wilderness) areas would not be exceeded.	See 1980.	See 1980.
	NO_2 levels would increase in and around towns with increases in population, but would not exceed state or federal standards.	See 1980.	See 1980.
	Regional CO concentrations resulting from operation of power plants, vehicular travel, and town growth would be expected to increase near larger towns, but would not exceed state or federal standards.	See 1980.	See 1980.
	Regional non-methane hydrocarbons (NMHC) concentrations would increase with population growth.	See 1980.	See 1980.
	Baseline concentrations of non-methane hydrocarbons (NMHC) currently exceed the federal standard (446 ug/m^3 v. 160 ug/m^3) (3-hour average). All NMHC levels with additional development of federal coal would exceed short- and long-term standards because of high baseline levels near towns. High concentrations would decrease to baseline levels 7 to 9 miles from towns.	See 1980.	See 1980.
	Reduction in visibility could be expected near mines and towns, but would increase rapidly at short distances from principal sources.	See 1980.	See 1980.
Soils	Surface disturbance: see Topography, 1980. Soil productivity would be permanently lost on soils permanently disturbed.	Surface disturbance: see Topography, 1985.	Surface disturbance: see Topography, 1990.
	Naturally developed soil horizons, structure, parent material, soil microclimates, permeability, and inflitration rates would all be lost or reduced on all disturbed soils: 7,900 acres by 1980, of which, 1,610 acres due to additional federal coal.	See 1980; 11,810 more acres disturbed, of which 4,345 due to additional federal coal.	See 1980; 9,060 more acres disturbed, of which 3,455 due to additional federal coal.
	Loss of exposed soils by wind and water erosion; unquantifiable.	See 1980.	See 1980.
	Loss of soils due to ORV use: unquantifiable, but increases with population (see Recreation).	See 1980.	See 1980.
Vegetation	Removal of vegetation: see disturbance, Topography.	See 1980.	See 1980.

1/ Only significant impacts are listed.

TABLE 4-45 (Cont.)

SUMMARY TABLE OF IMPACTS 1/

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Vegetation (Cont.)	Unavoidable temporary loss of production: 3,830 AUMs by 1980; of this, 350 AUMs due to additional federal coal.	Unavoidable temporary loss: 5,420 AUMs more by 1985; of this, 1,510 AUMs due to additional federal coal.	Unavoidable temporary loss: 5,440 AUMs more by 1990; of this, 1,860 AUMs due to additional federal coal.
	Permanent loss of production: 510 AUMs per year by 1980; of this, 210 AUMs per year due to additional federal coal. Impact small and localized.	Permanent loss of production: 1,340 AUMs per year by 1985; of this, 640 AUMs per year due to additional federal coal. Impact small and localized.	Permanent loss of production: 1,660 AUMs by per year by 1990; of this, 820 AUMs per year due to additional federal coal. Impact small and localized.
	Reclamation (regrading to original contour and revegetation) of temporarily disturbed soils; 200 acres by 1980, of which 100 acres due to additional federal coal. Grazing restored 4 years after reclamation begun.	By 1985, 5,160 more acres reclaimed, of which 470 acres due to additional federal coal.	By 1990, 7,310 more acres reclaimed, of which 2,030 acres due to additional federal coal.
	Loss of vigor and diversity, sucessional stage. Time to reestablish vegetative ecosystem would be 20 to 50 years.	See 1980.	See 1980.
	Over utilization of adjacent areas by wildlife and domestic fauna.	See 1980.	See 1980.
Animals			
Wildlife	No significant impacts on wildlife.	See 1980.	See 1980.
Domestic Fauna	For temporary and permanent loss of production, see Vegetation. Losses would be small and localized.	See 1980.	See 1980.
Aquatic Biology	Permanent loss of aquatic habitat due to disturbances of land - 165 acres by 1980; of this, 70 acres due to additional federal coal. Impact very minor.	Permanent loss of habitat: 435 acres by 1985; of this, 200 acres due to additional federal coal. Impact very minor.	Permanent loss of habitat: 540 acres by 1990; of this, 265 acres due to additional federal coal. Impact very minor.
	Degradation of water quality due to overtaxing of sewage facilities as population increases: cannot be quantified. See Recreation.	See 1980.	See 1980.
Cultural Components			
Archeological Resources	Casual collection would result in loss or mixing of diagnostic data used to interpret interrelationships between prehistoric peoples and theri environments. Loss cannot be assessed.	See 1980.	See 1980.
	Loss of unidentified surface and buried sites where community expansion would occur. Not quantifiable.	See 1980.	See 1980.
	Loss of paleoecological data on federal and non-federal leases. Not quantifiable.	See 1980.	See 1980.
	Loss or disturbance of recorded and unidentified surface or buried sites on lease sites and along rights-of-way on both federal and non-federal leases. Not quantifiable.	See 1980.	See 1980.
	Loss of archeological resources because of subsidence above underground mines. Not quantifiable.	See 1980.	See 1980.

TABLE 4-45 (Cont.)

SUMMARY TABLE OF IMPACTS 1/

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Cultural Components (Cont.)			
Archeological Resources (cont.)	Uncovering of archeological materials and inventorying and recording of sites otherwise not discovered, but materials lost for application of better archeological analysis methods developed in future.	See 1980.	See 1980.
Historic Resources	Increased vandalism of historic sites as population would increase. Not quantifiable.	See 1980.	See 1980.
	Destruction of "historic atmosphere" in towns because of displacement of older structures by new construction. Not quantifiable.	See 1980.	See 1980.
Aesthetics	Impacts to landscape character: (1) support facilities for new population, (2) mining on steep terrain resulting in barren cut fill slopes, (3) surface facilities not blending with landscape, and (4) construction of roads, railways, and electric distribution lines on steep terrain or bedrock material contrasting with surrounding landscape. Not quantifiable until specific lease sites are established, but general areas likely to be impacted are described in text.	See 1980.	See 1980.
	Dust, pollution, noise would adversely affect aesthetic quality of area. Not quantifiable until lease sites established.	See 1980.	See 1980.
Recreation	Deficiencies in swimming and tennis opportunities in Routt and Moffat Counties, hunting opportunities in Routt County. Not quantifiable, but would increase as population would increase.	See 1980.	See 1980.
	Minor increase in use of developed recreation sites in the study area. Not quantifiable.	See 1980.	See 1980.
	With disturbance of land for mining and ancillary construction (see Topography), loss of hiking, ORV, and viewing opportunities. Subsidence could also be hazardous to these activites after reclamation. Not quantifiable.	See 1980.	See 1980.
	With increased population, increases in coliform levels (see Aquatic Biology) on White and Yampa Rivers; Yampa could become ineligible for designation under Wild and Scenic Rivers Act. Also, possible curtailment or prohibition of water-contact sports.	See 1980.	See 1980.
	Mining would provide human-interest and education opportunities.	See 1980.	See 1980.
Socio-Economic Environment	Demographics: Geographical distribution of population would be altered, becoming increasingly urban.	See 1980.	See 1980.

1/ Only significant impacts are listed.

TABLE 4-45 (Cont.)

SUMMARY TABLE OF IMPACTS 1/

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Cultural Components (Cont.) Socio-Economic Environment (cont.)	All three counties and most municipalities (except Yampa and Dinosaur) would significantly increase in population. Trends in Moffat County would mirror those in Craig: 11 percent decline in population from 1977 to 1980, because of completion of construction of Craig Power Plant. Rio Blanco County would experience only a limited impact with additional development of federal coal, increasing 16 percent to 8,000 because of three oil shale projects there. Routt County's population would increase steadily due to development of mining, tourism, and recreation industries, 5 percent per year to 12,200 by 1980.	Moffat County would increase in population 9 percent per year, to 14,000 by 1985. Rio Blanco County would increase in population 14 percent per year, to 15,500 due to three oil shale projects. Routt County would increase in population 9 percent per year, to 19,100 by 1985.	Moffat County would increase in population 5 percent per year, to 17,700 by 1990. Rio Blanco County would decline in population 1 percent per year after completion of oil shale projects, to 14,500 by 1990. Routt County population would increase 3 percent per year, to 22,200 by 1990.
	Employment: Moffat County most affected by mid-level development. By 1980, additional coal-related development would cushion growing unemployment as the Craig Power Plant Units 1 and 2 are completed, but total employment would fall to 4,980 despite 140 new jobs due to additional federal coal development and its indirect economic impacts.	Total employment in Moffat County would be 6,180 by 1985 due to the direct and indirect effects of additional federal coal development.	Total employement in Moffat County would be 6,790 by 1990 due to direct and indirect effects of additional federal coal development.
	Rio Blanco County would experience little impact due to mid-level coal development, additional employment attributable to additional coal having little cushioning effect on unemployment after completion of the three oil shale projects. Total employment by 1980 would be 6,050.	Rio Blanco County would reap little benefit in employment from additional federal coal development. Total employment would reach 10,500 due to direct and indirect impacts of three oil shale projects.	Rio Blanco County's total employment would decline after completion of the three oil shale projects, to 10,240 by 1990.
	Mid-level coal development would substantially impact employment in Routt County, to 6,240 by 1980. Of this, 580 would be attributable to additional federal coal development. Increase in mining employment, though rapid, would not create short-term unemployment in the county because of the large unemployment labor force already there.	Total employment in Routt County under the impetus of mining at mid-level would increase to 8,690, 1,400 due to additional federal coal.	Total employment in Routt County under impetus of mining at mid-level would increase to 10,440, 1,830 due to additional federal coal.
	Income: the bulk of economic growth would be centered in the coal mining sector. The enlargement of this sector would be proportionally the largest in Routt County, coal mining constituting 30 percent of total earnings by 1980.	In Routt County, mining would contribute 39.9 percent of total earnings by 1985, making the local economy vulnerable to fluctuations in the coal market.	By 1990, mining would contribute 38.0 percent of total earnings, making the local economy vulnerable to fluctuations in the coal market.
	Mid-level development would have a similar but lesser impact on Moffat County. Additional coal development would take up some of the economic slack caused by completion of the Craig Power Plant Units 1 & 2; total earnings would decline 29 percent from 1977 to 1980. Coal mining would account for 27 percent of total earnings, making Moffat County vulnerable economically to fluctuations in the coal market.	At mid-level total earnings would be up 23 percent over 1980, to $64.3 million by 1985. Coal mining would account for 27.5 percent of total earnings, making Moffat County vulnerable economically to fluctuations in the coal market.	At mid-level, total earnings would be up 36 percent over 1980, to $70.5 million by 1990. Coal mining would account for 25.3 percent of total earnings, making Moffat County vulnerable economically to fluctuations in the coal market.
	The impact of mid-level development on Rio Blanco County would be relatively minor: only 0.2 percent of total earnings would be attributable to coal mining.	Coal mining would contribute only 2.7 percent of total earnings by 1985 in Rio Blanco County.	Coal mining would contribute only 5.6 percent of total earnings by 1990 in Rio Blanco County.

1/ Only significant impacts are listed.

TABLE 4-45 (Cont.)

SUMMARY TABLE OF IMPACTS 1/

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Cultural Components (Cont.) Socio-Economic Environment (cont.)	Increased wage and salary earnings at mid-level would intensify inflationary pressures in all three counties at least through 1985; highly-paid mine workers would be less hardhit than persons on low or fixed incomes.	See 1980.	See 1980.
	Economic effects of investment in coal mining would be concentrated in Moffat and Routt Counties. Direct fiscal benefits in terms of increased property tax assessments on mines would be confined to counties and school districts in which the mines would be located. The property tax base of nearby municipalities would benefit indirectly, from assessments on new worker housing and associated commerical development.	See 1980.	See 1980.
	Local Services: Public services and facilities would be overloaded in a number of communities in the three-county area; deficiencies include manpower and equipment. Deficiencies listed for time-points 1980, 1985, and 1990 are over and above those listed for the previous time-point. (Deficiencies for 1980 are over and above present levels).		
	Craig: none Dinosaur: police Meeker: fire, sewage Rangely: fire Hayden: once new sewage facility is finished, capacity sufficient through 1990. Oak Creek: police Steamboat Springs: fire	Craig: police, fire Dinosaur: none Meeker: fire, sewage Rangely: police, fire Hayden: police Oak Creek: fire Steamboat Springs: fire, water	Craig: police, fire Dinosaur: none Meeker: none Rangely: police Hayden: police, water Oak Creek: fire, sewage Steamboat Springs: police, fire, sewage, water
	Housing: Additional demand for single-family dwellings in Moffat County, increasing at 6.9 percent per year through 1990.	See 1980.	See 1980.
	76 percent of additional demand in Rio Blanco County would be for mobile homes; availability must increase at annual rate of 33 percent from 1977 to 1980. Availability of single-family units would have to increase 8.3 percent per year from 1977 through 1990 to meet demand.	Demand for housing would shift toward single-family homes (58.4 percent of total additional demand by 1985).	Demand for single-family homes 96.5 of total demand for new housing by 1990.
	All of the new housing demand in Routt County would be for single-family dwellings by 1980. Availability of single-family units would have to increase 7.0 percent per year from 1977 1990 to meet demand.	Of the total demand for new housing in Routt County by 1985, 80 percent would be for single-family dwellings.	Of the total demand for new housing in Routt County by 1990, 80 percent would be for single-family.
	Education: Fluctuations in school enrollment would reflect fluctuations in population by and large. Moffat - Craig: enrollment would drop from the current 2,464 to 2,109 in 1980. Rio Blanco - Meeker: enrollment would increase from the current 727 to 1,543 by 1980, 113 over projected capacity.	Moffat - Craig: enrollment would increase to 3,574 by 1985. Rio Blanco - Meeker: enrollment would increase to 3,029 by 1985, 1,486 over projected capacity.	Moffat - Craig: enrollment would increase to 4,696 by 1990, 916 over projected capacity. Rio Blanco - Meeker: enrollment would decrease to 2,810 by 1990.

1/ Only significant impacts are listed.

TABLE 4-45 (Cont.)

SUMMARY TABLE OF IMPACTS 1/

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Cultural Components (Cont.) Socio-Economic Environment (cont.)	Rio Blanco - Rangely: enrollment would increase from the current 617 to 674 by 1980.	Rio Blanco - Rangely: enrollment would increase to 1,464 by 1985, 194 over projected capacity.	Rio Blanco - Rangely: enrollment would decrease to 1,383 by 1990.
	Routt - Hayden: enrollment would increase from the current 508 to 691 by 1980.	Routt - Hayden: enrollment would increase to 1,288 by 1985.	Routt - Hayden: enrollment would increase to 1,920 by 1990, 300 over projected capacity.
	Routt - Steamboat Springs: enrollment would increase from the current 1,417 to 1,741 by 1980.	Routt - Steamboat Springs: enrollment would increase to 2,925 by 1985, 689 over projected capacity.	Routt - Steamboat Springs: enrollment would increase to 3,888 by 1990, 969 over projected capacity.
	Routt - South Routt: enrollment would increase from the current 483 to 487 by 1980.	Routt - South Routt: enrollment would increase to 787 by 1985.	Routt - South Routt: enrollment would increase to 1,025 by 1990, 120 over the projected capacity.
	Health Care: The region would experience a gradually growing deficiency in hospital beds, by 1990 a deficiency of 42. Some difficulty may be experienced in recruiting needed physicans and nurses: none of the counties has a major medical facility and Moffat and Rio Blanco Counties do not have a major recreation development such as a ski resort.	See 1980.	See 1980.
	Local Government Finances: Moffat and Routt Counties should experience significant increases in revenue surpluses due to greatly increased property tax assessments. Rio Blanco County may face front-end problems financing services for oil shale construction workers before property tax revenues begin to flow from completed plants. The long-term outlook is, however, good.	See 1980.	See 1980.
	Utilities: Purchase of electricity from companies outside the region would be necessary. Increased pipeline capacity from natural gas would also be necessary to meet mid-level population demands.	See 1980.	See 1980.
Transportation Networks	With increase in population, increase in area's total hazard ratings at railroad crossings - 8.21 by 1980, 2.87 attributable to additional federal coal. Also, area's total daily vehicle-waiting time for trains would increase to 17 minutes a day, 3 minutes of which would be due to additional federal coal.	Hazard ratings would increase to 8.30; of this, 3.60 due to additional federal coal. Vehicle waiting time would increase to 23 minutes of which 8 minutes due to additional federal coal.	Hazard ratings would increase to 8.40; of this, 4.60 due to additional federal coal. Vehicle waiting time would increase to 23 minutes of which 10 minutes due to additional federal coal.
	Roads designed for lighter traffic would receive heavy use due to transportation of coal; deterioration hastened (see Table 1-3 through 1-6).	See 1980.	See 1980.
	Area's total accidents per year would increase as population increases - 2,450 by 1980; of these, 360 due to additional federal coal.	By 1985, 2,700 accidents per year in the study area, 400 of these attributable to additional federal coal.	By 1990, 3,000 accidents per year in the study area, 490 of these attributable to additional federal coal.

1/ Only significant impacts are listed.

CHAPTER 5

ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

This chapter describes only the adverse impacts of development of coal at mid-level and of other related developments in the study area.

An attempt has been made in this chapter to assign relative importance to impacts and to rank them on that basis, in order to broadly evaluate the possible consequences of coal development. There are some difficulties in doing this. The total picture suggested by this ranking may vary with alternative points of view and alternative rankings. In addition, the impression of the consequences of development given by citing individual impacts cannot help but be somewhat fragmented. The combined effect of land disturbance, the diminution of air quality around towns, the taxing of public facilities and services to their limits with growth of population, and the alienation that is inevitable as value systems of long-term and newer residents of towns come into contact may be more compelling than the analysis of these impacts individually may convey. Forming an overall picture of how the character of the study area would be altered by additional development is essentially the task of the individual reader.

Despite difficulties inherent in this mode of presentation, the ranking of impacts does help to broadly characterize the adverse consequences of development. In some respects, ranking impacts according to importance seems arbitrary, because it is often difficult to regard the importance of a given effect as distinct from that of its antecendent cause. If, for example, the increase in dissolved solids levels in rivers is an important impact of mining activity, how can it be considered more important than the clearing of vegetation and the disturbance of the land surface, which must occur first?

The same problem exists when evaluating certain effects locally and evaluating them regionally. For example, the increase in dissolved solids in rivers near mines may be of little significance locally but may impact areas downstream in the lower Colorado River in a major way, because salinity of the water there is already high. Notwithstanding these difficulties, adverse impacts are identified and their importance evaluated independent of their place in the cause-and-effect chain. The order in which environmental components are presented in this chapter differs from their order in previous chapters, reflecting the inferred relative importance of the principal adverse impacts organized under them. Other, lesser impacts are included with the major ones for a given environmental component, for ease of presentation and for ready reference.

Trends of change in the study area indicated below are already taking place. Additional development of federal coal would speed and intensify these changes. Impacts of additional development would derive principally from the influx of new population into the study area and from disruption of the physical environment by mining and related activities.

Additional development of federal coal would have certain adverse impacts on the socioeconomic environment of northwest Colorado. The influx of outsiders into the study area accompanying development would intensify longterm residents' sense of the progressive erosion of traditional community values and loss of control over their destiny. Among the new residents drawn by the possible coal development many would experience the same sense of isolation and alienation experienced by longterm residents in the study area.

Additional development of federal coal would intensify the projected shortterm shortage of workers in the nonmine related sectors of Rio Blanco County as employers compete for available workers. Similar shortterm labor impacts would not be felt in Moffat and Routt Counties due to the current surplus labor situation. In the longer term, the influx of additional population attracted by the resulting economic opportunities should ease the shortage in Rio Blanco County somewhat, possibly even leading to local labor surplus.

Total wage and salary earnings and average earnings per worker would increase. This increase in income would lead to local inflation, reducing the effective buying power of persons with low or fixed incomes.

As a result of this inflationary trend as well as the limited supply of housing of all types except mobile homes, an increased number of households would be forced, at least in the short term, to accept housing that is not up to their expectations or desires.

Schools would become crowded, and pupil/teacher ratios would rise, requiring facilities expansion and staff increases. Current municipal services such as police, fire, water and sewage treatment would require expansion. Local communities in some cases would face short-term operating deficits if they expanded local services to meet the expected demand, while others would have to incur longterm indebtedness in order to provide needed capital facilities. The present shortage of health care specialists and facilities would become still more acute.

WATER RESOURCES

Development of additional federal coal would have certain unavoidable adverse impacts on the physical environment. These would be chiefly due to surface disturbance of the land, including mining activities, development of ancillary facilities and increased urbanization. Cumulative surface disturbance at mid-level would be 7,900 acres from 1978-80, 11,810 acres from 1981-85, and 9,060 acres from 1986-90, totaling 28,770 acres. Additional federal coal at mid-level would account for 1,610 acres from 1978-80, 4,345 acres from 1981-85, and 3,455 acres from 1986-90, totaling 9,410 acres.

Surface mining disturbance at mid-level would account for 3,280 acres from 1978-80, 7,310 acres from 1981-85, and 7,330 acres from 1986-90, totaling 17,920 acres. Additional federal coal surface mining disturbance would account for 470 acres from 1978-80, 2,030 acres from 1981-85, and 2,500 acres, totaling 5,000 acres.

The principal unavoidable adverse impacts to water resources as a result of surface disturbance of the land would be the removal of parts of certain aquifers within the mined areas and the alteration or removal of all natural stream channels in those areas where the surface is disturbed. The magnitude of these impacts in relation to the coal and study areas is summarized as follows:

TABLE 5-1

SUMMARY OF ADVERSE IMPACTS TO WATER RESOURCES
IN THE STUDY AREA

Resource	1978-80	1981-85	1986-90	1978-90
Approximate area of aquifers removed, in square miles (sq-mi)	7.4	19.4	23.0	49.8
Percent of coal area in which aquifers would be removed	0.7	1.9	2.3	4.9
Percent of study area in which aquifers would be removed	0.08	0.22	0.26	0.56
Approximate surface area disturbed by surface and underground mining (sq-mi)	12.3	18.4	14.2	45.0
Percent of coal area in which stream channels would be altered or removed	1.2	1.8	1.4	4.5
Percent of study area in which stream channels would be altered or removed	0.14	0.21	0.16	0.51

Because of the relatively small part of the study area that would be disturbed by cumulative development of coal at mid-level, removal of parts of aquifers (only 0.56 percent of the study area by 1990) and alteration or removal of stream channels (only 0.51 percent of the study area by 1990) should constitute a small, probably insignificant impact on the regional ground-water and surface-water systems. These actions, however, would alter the hydrologic system locally by interrupting premining ground-water flow, by degrading water quality from leaching of spoil materials, by increasing consumptive use of water, and by increasing erosion in disturbed areas and consequent sediment yield downstream. Any degradation in the quality of water yielded to the Colorado River system must be regarded as a serious impact inasmuch as the dissolved solids content of the river below Hoover Dam currently exceeds desirable limits and any increase in sediment load reduces the useful life of impoundments such as Lake Powell and Lake Mead. A brief description of these impacts follows.

Interruption of premining ground-water flow by dewatering of mines and by modification of flow patterns by replaced spoil materials would tend to lower water levels in wells adjacent to mines and dry up some springs. Although no complete inventory of wells and springs is available for the study area, cumulative development at midlevel would probably adversely impact less than 1 percent of existing water supplies.

Degradation in water quality would occur from leaching of replaced spoil materials in surface-mined areas and from intercirculation of ground waters between aquifers connected by permeable spoil materials or by vertical fracturing associated with underground mining. The effects would be long-term and probably would increase dissolved solids concentrations locally to about 2,500 to 3,000 mg/l. This water would be suitable for use by livestock and wildlife, but is not recommended for domestic use. Dissolved solids load in the Yampa River from this source would probably average about 10,000 tons/year during the period 1978-90 as a result of cumulative mid-level development. Municipal wastes, coupled with the above sources of pollution, would increase the weighted average of dissolved solids in the Yampa River by only 0.8 percent by 1990, but the corresponding increase in dissolved solids concentration in the Colorado River below Hoover Dam of about 0.6 mg/l by 1990 (Table 44) would be significant, even though it represents an increase of only 0.09 percent. The salinity of Colorado River water is critical to productive use of water in the southwestern states and Mexico and has proved to be a volatile political issue.

Water losses from interception of runoff and storage of water in impoundments and sedimentation ponds would be minor, probably averaging less than 0.01 percent of total runoff from the study area. Consumptive use of water as a result of development of additional federal coal at mid-level is expected to reduce total water yield from the study area by about 0.2 percent by 1980, increasing to about 0.4 percent by 1985, and remaining at about that level through 1990 (Table 4-4). The small reduction in total runoff as a result of cumulative development at mid-level should have no significant impact on the study area, which normally produces runoff far in excess of water needs. Local water rights

are protected by regulations (Chapter 3, Water Resources). Any reduction in flow downstream into the Colorado River system, however, would reduce the amount of water available to the water-deficient Lower Basin States and must be regarded as a significant impact to these states.

TRANSPORTATION NETWORKS

Impact on transportation networks would be caused by (1) transportation of coal out of the study area, and (2) increased employment and population, with its attendent increase in vehicles and miles-traveled.

As a result of both increased train and auto traffic, the incidence of auto-train collisons at grade crossings would increase. The cumulative hazard ratings for crossings in the study area are 8.13 for 1976, 8.21 by 1980, 8.30 by 1985, and 8.40 by 1990. The increase in hazard ratings due to additional development of federal coal are 2.87 by 1980, 3.60 by 1985, and 4.60 by 1990. Hazard ratings are the number of auto-train collisions expected in a 5-year period.

As a result of increased train traffic, the average daily vehicle waiting time at unseparated grade crossings would increase. Assuming a three-minute delay per train, daily vehicle waiting time at midlevel would increase from the present 12 minutes per day to 17 minutes per day by 1980, 23 minutes by 1985, and 23 minutes by 1990. Delays attributable to additional development of federal coal would be 3 minutes by 1980, 8 minutes by 1985, and 10 minutes by 1990. This would be especially significant to emergency vehicles, which would have no alternate route. The impact to emergency services is difficult to quantify because there are no data on the probability of an emergency vehicle being delayed in the study area.

A marked increase in loaded diesel coal truck traffic could impact the study area. Most highways in the region were designed for light traffic and although paved, would deteriorate rapidly if repeatedly used by heavy coal trucks of 25 to 30 net tons per load. Because of increases in heavy truck traffic as well as regular traffic, roads would require more maintenance at a higher cost. Two roads that would suffer greatest deterioration would be State Highway 13 between Axial and Meeker and State Highway 394 from U.S. 40 to the coal rail loading site just south of Craig. Meeker, Craig, Hayden, and Steamboat Springs would all share in the impacts of increased vehicular traffic, both from heavy trucks and passenger vehicles. Tables 1-3, 1-4, 1-5, and 1-6, Chapter 1, indicate cumulative coal-related impacts at the mid-level and increments of those impacts attributable to additional development of federal coal.

Traffic volume increases at mid-level would result in more accidents, by 1980, 2,450 accidents in the study area, 2,700 by 1985, and 3,000 by 1990. Accidents attributable to additional development of federal coal would be 360 by 1980, 400 by 1985, and 490 by 1990. Increased vehicular traffic would also result in higher annual maintenance costs for roads.

Coal from the two coal mining regions west of the study area and coal from central Utah would travel east to market by rail. If there were a high level of development, traffic would increase to the point where there would be little room for general traffic growth without major modifications to the main-lines. In addition, traffic congestion

problems would be further aggrevated on the east slope.

Rail lines generally pass through the center of communities. More rail traffic would essentially disrupt established traffic circulation patterns in towns and separate many essential community facilities from their service areas.

The incidence of auto-train collisions would increase at unseparated grade crossings.

Coal development would not cause the regional air quality to deteriorate, but, within and at the boundary of some of the larger individual mines, the Class II PSD standards and national and Colorado air quality standards for total suspended particulates (TSP) would be exceeded through 1990. Beyond 2 to 4 miles from individual mines, annual TSP concentrations are predicted to be less than 1 ug/m^3 above baseline concentrations.

Additional development of federal coal would lead to small but noticeable increases of total suspended particulates (TSP) levels around the town of Craig. In 1980 and 1985, the annual and 24-hour TSP concentrations would increase by 3 ug/m^3 and 10 ug/m^3, respectively. By 1990 the annual and 24-hour TSP concentrations near Craig would be approximately 5 ug/m^3 and 17 ug/m^3 greater than 1977 levels, due primarily to town growth. The area affected would have a radius of less than 2 miles from the center of Craig. Smaller increases would occur around other towns in the study area.

Horizontal visibilities are expected to exceed 48 miles almost 50 percent of the time in the region as a whole if cumulative development at mid-level occurs. Regional visibilities (related to atmospheric particulates) would be reduced to 43 miles or less over small areas around major towns in the study area, due, in part, to growth in urban emissions caused by cumulative development at mid-level. Reduced visibility would not extend much beyond 8 miles from the towns. Much lower visibility could occur near specific sources within towns, but it would be very localized.

During the study period, average regional visibilities would be reduced to 35 miles or less over areas 1-2 miles in diameter around larger mines. Beyond 3-4 miles from even the larger mines annual regional visibilities would not be reduced. Much higher short-term visibility reductions would occur very close to individual mines, but these would be highly localized.

Coal development may change the surface meteorology at the mine sites by altering the surface contours, albedo and material distribution, and temporarily reducing vegetation during mining.

ARCHEOLOGICAL RESOURCES

There would be five major unavoidable adverse impacts on archeological resources.

1. Casual collection from uncontrolled digging into surface and buried sites on leases and throughout and beyond the study area would occur. Such activities might be concentrated on and near lease areas and very diffused within and beyond the study area. Removal of artifacts and destruction or disturbance of cultural deposits results in the loss or mixing of diagnostic data, both obvious and subtle, used by professional archeologists to analyze and interpret the interrelationships between prehistoric peoples and their environments.

2. Loss of unidentified surface and buried sites in areas where community expansion would occur.

3. Loss of paleoecological data on federal and non-federal leases and throughout and beyond the study area would occur.

4. Loss or disturbance of recorded and unidentified surface or buried sites during construction activities on lease sites and along related rights-of-way would occur, both on federal and non-federal leases.

5. Damage to and loss of archeological resources above underground operations would occur. This impact is ranked lowest because geologists judge that subsidence probably would not reach the surface above most of the underground operations in the study area, and where it would reach this surface, it would still be less of an impact than the others listed.

Some specific impacts resulting from mid-level production can be identified, but most of the federal and state development areas have not yet been surveyed and no predictive model exists to estimate site density or pattern. There is no legal requirement that resources on private leases and areas of community expansion be identified or evaluated for significance. The state leases have not yet been surveyed.

By 1980 six private leases would be actively mined. Their resources would be considered lost. The three state leases to be mined have not been surveyed and cannot be assessed. Sixteen existing federal leases and any issued short-term leases would be active. Eleven of the existing leases must be archeologically surveyed. Forty sites are presently recorded in areas of development. Five sites are presently recommended for inclusion on the National Register of Historic Places (NRHP): 5MF435, 5MF444, 5MF681, 5RT30 and 5RT32 (Table 2-23). Despite protective mitigation, casual collecting could occur at all sites that are not preserved through excavation. Rock art at several sites could be vandalized. Unidentified sites within the pit areas of federal and state leases would be lost. Community expansion would develop 400 acres, of which 320 acres would be due to additional federal coal. All involved sites would be assumed lost.

By 1985 ten private leases could probably be mined; their sites would be considered lost. At least eighteen existing federal leases and any issued short-term leases would be active. Fourteen of the existing leases need archeological survey. At least five state leases would be mined. These state leases have not been surveyed. While the number of recorded sites remains constant from 1980, required surveys would record additional sites. Casual collection could continue to occur at all sites that are not preserved through excavation. Unidentified sites in the pit areas of federal and state leases would be lost. Community expansion would develop 1,870 acres, of which 780 acres would be due to additional federal coal. All involved sites would be assumed lost.

By 1990, seven private leases could still be active, their archeological resources lost. Thirteen existing federal leases and any issued short-term leases would probably be active. Much of the area needs to be archeologically surveyed. At least four state leases would be mined and active. Surface collection could continue to occur on the 41 recorded sites and any additional sites found. Unidentified sites in the pit areas of federal and state leases would be lost. Community expansion would develop 580 acres, of which 430 acres would be due to additional federal coal. Any sites existing on this land would be assumed lost.

The majority of the 41 recorded sites appear to have data which should be important in describing adaptations of Plains Archaic technology that may have been developed in the eastern portion of the study area during a span of 5,000 years ago to 10,000 years ago. Data from these sites may be valuable to prehistoric reconstruction within the study area and within the Northwestern Plains. Several sites document the activities of historic Utes before they were moved to a reservation. Data from these resources may be important to reconstruction of the Ute culture before and after contact with Europeans.

The most significant recreation impacts result from population increases associated with mining. The population increases in the region based on the midlevel scenario is as follows: 1975 25,929; 1980 29,900; 1985 48,600; and 1990 54,400.

Generally it is difficult to assess recreation impacts from population growth because there is a lack of data from which to make projections. Data presented in the Colorado State Comprehensive Outdoor Recreation Plan indicates there is generally a surplus of recreation opportunities available within the study area. Losses of recreation opportunities in mining areas would therefore be negligible.

With increased population, there would be increased pressure on towns' sewage treatment facilities, which would lead to increased fecal coliform levels downstream in the Yampa and White Rivers. These increases could make the Yampa River ineligible for designation under the Wild and Scenic Rivers Act.

All developed recreation sites within the region would be expected to have minor impacts from increased recreation demands resulting from cumulative development at mid-level. These impacts would be permanent and would increase gradually from 1980 to 1990. Those areas closest to municipal centers would be affected most. These include Ralph White Reservoir, Elkhead Reservoir, Ferndale, Harrison Creek, and Cristina Picnic Grounds, Meadows, Dry Lake and Summit Creek Campgrounds, and Lake Avery and Rio Blanco Lake State Recreation Areas (see Map Foldout 12 in Appendix B, NWCCRES).

Increases in outdoor recreational activity would also increase the demand for urban recreation in the region. According to the most recent (1974) projections of recreation demand (Table RII-26 of the NWCCRES), Routt County had deficiencies of 11,200 activity days for swimming and 2,900 days for tennis. Moffat County had a deficiency of 14,900 activity days for tennis, but none for swimming. Projections for the future could not be made because no data were available, but deficiencies which already exist would be expected to increase as population would increase.

Development at mid-level would not directly impact wilderness values, but population increases resulting from this development would increase the demand for wilderness recreation. The Flat Tops Wilderness Area and the Mt. Zirkel Wilderness Area are the only two formally designated wilderness areas in the study area. Currently, BLM is inventorying its land for wilderness potential. There are no data from which to make projections of impacts on wilderness values as population increases, but they may be minimal because many wilderness opportunities occur in the study area.

Loss of recreation opportunities from land disturbance associated with mining and ancillary development at mid-level would occur principally in Twenty-Mile Park and Hayden Divide south of Hayden, Nine Mile Gap northeast of Meeker, and the confluence area of the Yampa and Williams Fork Rivers southwest of Craig.

When land is disturbed due to mining and ancillary developments, recreation opportunities are impacted in several ways. Access to recreation areas may be blocked. The mined area's natural landscape is disturbed through removal of vegetation and modification of topography, including removal of interesting rock formations. The area could not be used for hiking, cross country skiing/snowshoeing, backpacking, nature study, photography, ORV activities, horseback riding, collecting, camping, and picnicking. In some small areas there would be surface cracking large enough to be a safety hazard to foot, horseback, or vehicle travel, especially motorcycling.

Loss of land during active mining operations would result in loss of habitat for wildlife. Ultimately, this would diminish hunting and wildlife viewing opportunities, but the study area has a surplus of such opportunities so this impact would be minor.

VISUAL RESOURCES

Coal development in northwest Colorado would significantly alter the existing landscape character and accompanying inherent aesthetic values. These significant impacts are: (1) severe visual impacts resulting from many services and support facilities needed to support new population, (2) operations (mining) on steep terrain (+35°) resulting in barren cut and fill slopes, (3) surface facilities (building, mine portals, tipples, stacks) not blending with the landscape, (4) road construction, railways, and electric distribution lines on steep terrain (+35°), or on bedrock material.

The visual impact of surface mines themselves could only be partially reduced. Until successful reclamation occurs, impacts of the mining operation itself would be unavoidable. Reclamation would reduce most of them.

Surface facilities at both surface and underground mines, as well as powerplants and many coal-related urban developments, could not completely borrow from the characteristic landscape features. Buildings, mine portals, tipples, emission stacks, and yarding areas contain inherent elements that can never totally blend with adjacent terrain. Painting with special colors, careful attention to architectural design, and screening techniques would only partially mitigate impacts; there is no possibility of totally eliminating all of these impacts. Roads and railroads have inherent features whose strong line-dominance is never totally mitigated. Those rights-of-way constructed on steep side-slopes, or in bedrock material, or those which fail to borrow from naturally occurring line-dominant features would impact the aesthetic environment adversely.

All dust, air pollution, and noise impacts could not be totally mitigated. Size of the areas of possible coal development, adverse wind, nature of overburden blasting, and coal loading procedures, would make total dust, air, and noise control infeasible. Total control of suspended particulates at housing developments in urban areas would not be feasible either. The result would be visual impacts in the form of haze and smog (see discussion of Air Quality).

Impacts on the region's mood-atmosphere values of isolation, solitude and inspiration could not be completely mitigated. The relative significance of these unavoidable adverse impacts would depend on the visual exposure of the landscape visual units in which they occur. The most severe impacts would be those that can be viewed most directly, for the longest travel time, from the greatest number of points, and at the closest distance.

Major U.S. and Colorado highways provide visual access throughout the region. In addition, areas of possible coal development are traversed by county roads. Regularly scheduled commercial flights on Frontier Airlines into Hayden, and on Rocky Mountain Airways into Steamboat Springs

and Craig, would provide passengers with views of the region at moderately low altitudes.

Visual impacts would be observed mostly in southwest Routt County, southeast Moffat County, and the area northeast of Meeker in Rio Blanco County.

MINERAL RESOURCES

The major impact to mineral resources would be the removal of a cumulative total of 320.65 million tons of coal from the study area by 1990. Coal production in the study area would be 20.3 million tons per year by 1980, 27.5 million tons per year by 1985, and 28.3 million tons per year by 1990. This represents 0.8 percent of the 38 billion tons of measured, indicated, and inferred coal reserves in the study area (Landis 1959). Development of additional federal coal at mid-level would account for 95.97 million tons of the total coal mined by 1990. Coal production from the development of additional federal coal would be 3.7 million tons per year by 1980, 9.3 million tons per year by 1985, and 12.4 million tons per year by 1990.

Approximately 130 million tons of coal would not be recovered because of losses inherent in the method used to extract the coal. Approximately 51 million tons of this unrecovered coal would be due to the additional development of federal coal at mid-level. Underground mining would recover approximately 50 percent of the economically minable coal, surface mining methods approximately 90 percent of the economically minable coal.

Mineral resource conflicts may occur between development of coal and development of oil and gas, and to a lesser extent, uranium. Conflicts with oil and gas rarely occur, but result when resources occur at the same horizon; they would be based on superimposed occurrence of coal near the surface, and oil and gas at depth. Because these resources normally can be recovered sequentially without notable increase in environmental impacts over those accruing with separate recovery, the impacts of coal vs. oil and gas conflicts would be insignificant in a regional sense.

Potential conflicts between coal and uranium are not known at this time. Known resources of uranium, particularly in the Maybell area, do not occur in the same area as coal nor are they attractive for development, and recovery would not jeopardize future recovery of coal. Increases in world demand and price for uranium, however, have accelerated exploration for uranium in northwestern Colorado and new discoveries are possible. It is improbable that mining for one resource would jeopardize future mining of the other.

TOPOGRAPHY

Mining would result in temporary disturbances to the topography in coal mining areas (southwest Routt County, southeast Moffat County and the area northeast of Meeker). Although this temporary disturbance (mining pits and spoil piles) would represent the greatest alteration of the topography it would only exist for the life of the mine. Temporary disturbance would occur over 5,160 acres by 1980, an additional 7,310 acres by 1985, and an additional 7,330 acres by 1990 for a total of 19,800 acres. Temporary disturbances of surface area due to the additional development of federal coal would be 470 acres by 1980, an additional 2,030 acres by 1985, and an additional 2,500 acres by 1990 for a total of 5,000 acres.

Long-term developments such as mine buildings and shop facilities, railroads, and housing developments would cause minor alterations to the topography in areas of coal mining, as listed above, and areas of population growth (Meeker, Craig, Hayden, Oak Creek, and Steamboat Springs). These changes are considered permanent for the time frame of this report. These disturbances would affect 2,740 acres by 1980, an additional 4,500 acres by 1985, and an additional 1,730 acres by 1990 for a total of 8,970 acres permanently disturbed by 1990. Of this acreage, 1,140 acres would be disturbed due to the additional development of federal coal by 1980, an additional 2,315 acres by 1985, and an additional 955 acres by 1990 for a total of 4,410 acres permanently disturbed by 1990.

There would be permanent impacts to the topography as a result of temporary disturbances. Existing natural surfaces would be replaced with man-made surfaces with artificial drains. Although the affected areas would be returned to their approximate original contour, the resulting angles of relief would not be as sharp, and large boulders and rock outcrops would be missing. Areas where overburden is replaced at a higher or lower general surface level than the original surface would not be expected to be apparent to the casual observer.

In the absence of specific mining plans, the magnitude of subsidence-related impacts and the area affected cannot be determined. Most underground mining in the study area would utilize continuous underground room and pillar methods (Table 1-1). Subsidence in conjunction with the room and pillar method is expected to be minimal. Some tension cracks would probably reach the surface, but no significant lowering of the surface during or following mining should occur. Subsidence as a result of the longwall method, which removes large blocks of coal and encourages roof collapse in the mined-out areas, may reach a few tens of feet, but should average less than 10 feet. This method, however, would be little-used in the study area.

So far as could be determined, possible subsidence and related fracturing as a result of cumulative development at mid-level would jeopardize no existing structures or public roadways. Any changes in topography should be subtle and have minimal effect on surface drainage.

Cracks should fill rapidly with debris and sediment and should present no greater hazard to wildlife than existing steep-sided gullies or arroyos.

PALEONTOLOGY

Impacts to paleontological resources would consist of losses of plant, invertebrate, and vertebrate fossil materials for scientific research, public education (interpretive programs), and to other values. Losses would result from destruction, disturbance, or removal of fossil materials as a result of coal mining activites, unauthorized collection, and vandalism.

Losses of paleontological materials due to unauthorized collecting and vandalism would increase as population increases, but no data exists to correlate losses with general population increase.

Losses to paleontological values due to coal-related operations would occur especially in the vertebrate fossil-bearing formations in areas of coal development. These values are mammalian and other vertebrate fossils of the Wasatch and Fort Union Formations 5 to 10 miles west of Craig, Colorado, of the Fort Union and Lance Formations 10 miles northeast of Craig, and other unspecified vertebrate fossils of the Bridger Formation 5 to 10 miles south of Craig.

Development of additional federal coal would have certain unavoidable adverse impacts on the physical environment. These would be chiefly due to surface disturbance of the land including mining activities, development of ancillary facilities and increased urbanization. Cumulative surface disturbance at mid-level would be 7,900 acres from 1978-80, 11,810 acres from 1981-85, and 9,060 acres from 1986-90, totaling 28,770 acres. Additional federal coal at mid-level would account for 1,610 acres from 1978-80, 4,345 acres from 1981-85, and 3,455 acres from 1986-90, totaling 9,410 acres.

Surface mining disturbance at mid-level would account for 3,280 acres from 1978-80, 7,310 acres from 1981-85, and 7,330 acres from 1986-90, totaling 17,920 acres. Additional federal coal surface mining disturbance would account for 470 acres from 1978-80, 2,030 acres from 1981-85, and 2,500 acres, totaling 5,000 acres.

The permanent loss of soil productivity, from development of roads, mine facilities including surface and underground, power plants, railroads, and new housing, would be a significant unavoidable adverse impact. Soil productivity lost at mid-level would be 2,740 acres from 1978-80, 4,500 acres from 1981-85, and 1,730 acres from 1986-90, totaling 8,970 acres. Of this, development of additional federal coal would account for 1,140 acres by 1980, 2,315 acres by 1985, and 955 acres by 1990 for a total of 4,410 acres.

Loss of the natural soil along with naturally developed soil horizons, structure, parent material, soil micro-climates established over geologic time, and reduction in permeability and infiltration rates would be unavoidable in all disturbed areas. By 1990, loss of natural soil properties would occur on 28,770 acres from cumulative mid-level surface disturbance, 9,410 acres of that attributable to additional federal coal.

Due to the unpredictable nature of wind and high intensity rainstorms, some on-site soil loss from exposed soils could not be avoided. Soil erosion by water would be stopped by sediment ponds (see Water Resources), resulting in soil mixing and possible reduction in topsoil quality. At mid-level, all land subject to surface disturbance for mining and ancillary development would be susceptible to on-site erosion and mixing in sediment ponds. The magnitude of soil loss and loss of soil productivity cannot be determined due to the unpredictable nature of wind and water, but should be kept to a minimum because OSM regulations (715.16(a)(b)) stipulate protection of topsoil through revegetation and/or mulching. New housing developments and other urbanization would require 2,850 acres cumulative by 1990 at mid-level, 1,530 acres of which would be attributable to additional federal coal. Soil loss by wind and water from urban development would be unmitigated.

Increases in population resulting from additional coal development would create higher recreational demands such as off-road vehicle use (see Recreation). Localized compaction and soil loss related to increased off-road vehicle use is not quantifiable for the study area.

The cumulative mining soil disturbance at mid-level would result in a short-term reduction of soil productivity until those disturbed areas were restored (100 percent soil productivity achieved) and capable of supporting vegetation consistent with the previous land use (see Vegetation). There would also be a short-term reduction in soil productivity on the 1,880 acres disturbed for powerline construction from 1978-80 until this acreage would be capable of supporting the previous vegetation.

The greatest impact to vegetation would be its removal. Surface mine operations would directly remove vegetation from the immediate area of operations and from adjacent areas, due to haul roads, facility locations, and stockpile locations. Vegetation would also be removed by development of facilities for underground mines, housing developments, railroads, and the development of facilities to support population growth.

Development of coal resources at the mid-level would cause the temporary disturbance of 5,160 acres of vegetation by 1980, an additional 7,310 acres by 1985, and an additional 7,330 acres by 1990 for a total of 19,800 acres of vegetation disturbed by 1990. Of this acreage of vegetation temporarily disturbed, that attributable to development of additional federal coal would be 470 acres by 1980, an additional 2,030 acres by 1985, and an additional 2,500 acres by 1990 for a total of 5,000 acres by 1990.

Development of coal resources and ancillary development including urbanization would cause the permanent loss of 2,740 acres of vegetation by 1980, an additional 4,500 acres by 1985, and an additional 1,730 acres by 1990 for a total permanent loss of 8,970 acres by 1990. Of this, development of additional federal coal would account for 1,140 acres of vegetation by 1980, an additional 2,315 acres by 1985, and an additional 955 acres by 1990 for a total of 5,000 acres by 1990.

Temporary disturbance of vegetation would result in a loss of vegetative production. A period of approximately 4 years following the time of disturbance would occur before reclamation would have progressed sufficiently to permit grazing. The impact on domestic fauna would be localized and significant only to individual landowners.

The impact of lost production to wildlife would not be significant compared to the total wildlife populations of the study area (see Wildlife).

Total destruction of native vegetation from an area would result in additional impacts on the vegetative ecosystem. There would be significant loss of a diverse vegetation capable of withstanding climatic extremes and utilizing precipitation and sunlight throughout the growing season. There would also be a loss of the present vegetative successional stage. When a site is revegetated, a relatively small number of species would be present. This simpler vegetation would be more susceptible to climatic extremes and diseases.

Loss of soil productivity (see Soils) would extend the time needed for reestablishment of the former vegetative ecosystem. Since the time needed to establish these vegetative ecosystems has not been determined and no research has been done on the degree of loss of soil productivity associated with coal mining disturbance, the increases in time needed to reestablish the vegetative ecosystem cannot be predicted.

AQUATIC BIOLOGY

As additional coal development takes place in the study area adverse impacts to aquatic biology would result from population growth and developments ancillary to coal such as housing developments, power plants, and railroads. These developments would result in a permanent loss of aquatic habitat due to disturbance of land - 164 acres by 1980, 435 acres by 1985, and 540 acres by 1990. Disturbance due to development of additional federal coal would be 70 acres by 1980, 200 acres by 1985, and 265 acres by 1990.

Loss of aquatic habitat would also occur due to developments along perennial streams and increases in agriculture-related activities. Construction of housing along streams would claim cumulatively about 25 acres of aquatic habitat permanently by 1980, 135 acres by 1985, and 170 acres by 1990. Of this total, 19 acres would be attributable to development of additional federal coal by 1980, 66 acres by 1985, and 92 acres by 1990. As a result of land being disturbed for new housing, there would be more concentrated use of aquatic habitat in adjacent areas. Population growth would also create a direct loss of habitat from increases in agriculture-related activities. Domestic animals would utilize and damage already limited riparian habitat.

There are presently no known historic sites on land disturbed by mid-level development but examination of the study area is incomplete.

Secondary impacts would occur when development changes the character of a region. For instance, historic sites could be vandalized at increased rates as a result of population increases and the attendant visitor use increases. The development of roads, and railroads, would degrade the integrity of historic sites located in the region and near development by altering the aesthetic surrounding.

A less obvious secondary impact would result from population increases in established towns such as Craig, Steamboat Springs, Meeker and Oak Creek. New construction would displace older buildings and sites. This would destroy the "historic atmosphere" (the visual and aesthetic qualities of a site). However, certain areas both on the city and county level that are classified or zoned historic areas would be protected from rapid undisciplined development.

Undiscovered sites could also be harmed by subsidence, however, this impact would be minimal since lands subject to subsidence would have been inventoried and those sites located on lands prone to subsidence would have been recorded prior to development.

With mid-level development, permanent loss of habitat and direct loss of species are major unavoidable impacts. Habitat permanently lost would be 2,740 acres by 1980, 7,240 acres by 1985, and 8,970 acres by 1990. Of this, additional federal coal would account for 1,140 acres by 1980, 3,455 acres by 1985 and 4,410 acres by 1990. In addition, there would be a temporary disturbance of 5,160 acres by 1980, 12,470 acres by 1985, and 19,800 acres by 1990 from powerline construction and surface mining. Of this, additional federal coal would account for 470 acres by 1980, 2,500 acres by 1985, and 5,000 acres by 1990.

Portions of the area would be revegetated, but by 1990 none of the areas would be considered at carrying capacities comparable to existing wildlife habitat communties. It would take 30 to 70 years to establish comparable wildlife communties. Every species of terrestrial fauna in the study area, listed in Appendix D (NWCCRES), would be affected by loss of habitat. Because of a lack of species density and composition data for the majority of wildlife species it is impossible to estimate the reduction in carrying capacity for most non-game species that would result from mid-level coal development.

Permanently lost habitat would have the most significant impact on game species such as elk, mule deer, antelope, and sage grouse. This loss would be 6,100 acres of the total 8,970 acres lost by 1990. This represents only 0.20 percent of the entire study area. Permanent loss of habitat would probably result in the loss of some wildlife. This loss would not be significant; it would even be small compared to the number of animals lost each year to car-animal collisions between Craig and the Wyoming border. Elk and antelope would be displaced to surrounding areas. There would be a loss of some mule deer, since the population is near carrying capacity on critical habitat sites. Some sage grouse would also be lost, since the loss of habitat would result in destruction of strutting grounds, which are critical for production. The estimates in Table 4-17 represent the number of animals which could have been supported by the lost habitat through 1990.

Of the total acreage of deer habitat permanently lost, 30 percent is critical habitat, which will result in a direct loss of 27 deer by 1980, 70 deer by 1985, and 88 deer by 1990. This loss is due to the surrounding area not being capable of absorbing the displaced deer.

Winter range for elk, mule deer, and antelope is critical habitat. Their winter range contains sagebrush, mountain shrub, and aspen types. These types make up about 13,525 acres of the 19,800 total acres that would be temporarily disturbed by mining. This 13,525 acres is about 0.5 percent of the total sagebrush, mountain shrub, and aspen types available to these animals in the study area.

Half of all wildlife displaced permanently would be lost (Table 4-17). Elk lost would be an estimated 6 by 1980, 15 by 1985, and 20 by 1990. Deer lost: an estimated 27 by 1980, 70 by 1985, and 87 by 1990. Sage grouse lost: an estimated 7 by 1980, 18 by 1985, and 22 by 1990. Loss of antelope would be negligible.

One-third of all wildlife temporarily displaced would be lost (Table 4-14). Elk lost would be an estimated 7 by 1980, 16 by 1985, and 25 by 1990. Deer lost: an estimated 30 by 1980, 74 by 1985, and 120 by 1990. Sage grouse lost: an estimated 8 by 1980, 18 by 1985, and 30 by 1990. Antelope losses would be negligible.

The losses of these individuals would be insignificant compared to the total population of these wildlife species in the study area. For example, the loss of 120 deer by 1990 averages 10 deer lost per year from 1978 to 1990. This is not significant compared to current losses from disease, vehicle-animal collisions, old age, hunting, poaching, and harassment. Significance of the losses of elk, antelope, and sage grouse is even smaller.

Based on a current estimate from the Colorado Division of Wildlife of 600 road kills per year of big game animals and the estimated increased traffic volumes accompanying development of additional federal coal, big game road kills in the study area would increase, to 1,250 animals per year in 1990. These losses would not be significant compared to total wildlife populations.

Many smaller animals would be destroyed during mining, road and railroad construction, and building of homes, schools, powerplants, etc. The less mobile faunal species such as reptiles, invertebrates, and small mammals would not be able to flee and would be destroyed.

Some loss of watering sites would take place in the study area. Such loss of watering sites would alter use areas of both domestic and wild fauna, reduce reproductive effectiveness of amphibians, and change the food web that is associated with invertebrates The impact of this would probably be very minor.

DOMESTIC FAUNA

Loss of vegetative production would impact livestock. Accidental animal deaths would also be more likely from hunting-related activities. Rustling of livestock and damage to fences and other range improvement facilities would probably result from increases in human population and use of the region. Areas that would be affected are southwest Routt County, southeast Moffat County, and the area northeast of Meeker in Rio Blanco County.

The temporary disturbance to vegetation which would occur by 1980 would result in an eventual loss of 3,830 animal unit months (AUMs), the additional disturbance to vegetation occurring by 1985 would result in a loss of 5,420 AUMs, and the disturbance to vegetation by 1990 would result in 5,440 AUMs lost, totaling 14,690 AUMs. Of this, development of additional federal coal would account for 350 AUMs by 1980, 1,510 AUMs by 1985, and 1,860 AUMs by 1990, totaling 3,720 AUMs lost (Table 4-16).

The permanent loss of production resulting from the permanent loss of vegetation would be 510 AUMs per year by 1980, 1,340 AUMs per year by 1985, and 1,660 AUMs per year by 1990. Development of additional federal coal would account for 210 AUMs per year of this loss by 1980, 640 AUMs per year by 1985, and 820 AUMs per year by 1990 (Table 4-16).

The resulting decrease in livestock numbers could be significant to an individual livestock operator if the reduction of livestock numbers were to be a large enough percentage to affect the economics of the livestock operation. This cannot be determined until coal mining boundaries are proposed.

With the increased vehicle traffic discussed in the Transportation Networks section of Chapter 4, loss of livestock would increase due to vehicle-animal collisions. These losses would be significant only to individual landowners; they would not have regional economic significance.

SUMMARY OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Following is Table 5-2, which summarizes the adverse impacts which cannot be avoided with mid-level development.

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Geologic Setting			
Topography	Temporary disturbance of 5,160 acres by 1980 due to stripping of surface for coal mining. Of this, 470 acres due to additional federal coal.	Temporary disturbance of an additional 7,310 acres by 1985. Of this, 2,030 acres due to additional federal coal.	Temporary disturbance of an additional 7,330 acres by 1990. Of this, 2,500 acres due to additional federal coal.
	Permanent disturbance due to long-term developments like mine build- and shop facilities, railroads, and housing developments: 2,740 acres by 1980. Of this, 1,140 acres due to additional federal coal.	Permanent disturbance of an additional 4,500 acres by 1985. Of this, 2,315 acres due to additional federal coal.	Permanent disturbance of an additional 1,730 acres by 1990. Of this, 955 acres due to additional federal coal.
	Small amount of subsidence over underground mines; not quantifiable. No existing roadways or structures threatened.	See 1980.	See 1980.
Paleontology	Loss of plant, invertebrate, and vertebrate fossil material due to mining, unauthorized collecting and vandalism.	See 1980.	See 1980.
	Location of loss: 5 to 10 miles northeast, and 5 to 10 miles south of Craig, Colorado.	See 1980.	See 1980.
Mineral Resources	Removal of 20.3 million tons of coal per year by 1980. Of this, 3.7 million tons per year due to additional federal coal.	Removal of 27.5 million tons per year by 1985. Of this, 9.3 million tons per year would be additional federal coal.	Removal of 28.3 million tons per year by 1990. Of this, 12.4 million tons per year due to additional federal coal.
	Recovery ratio: 50% by underground, 90% by surface mining. After 1990, 130 million tons of unrecovered coal.	See 1980.	See 1980.
	Conflicts between oil and gas and coal: sequential recovery makes impacts small, but not quantifiable. Conflicts with coal vs. uranium unlikely.	See 1980.	See 1980.
Water Resources	Probable loss of a few springs	See 1980.	Loss of less than 1 percent of existing springs.
	Dissolved solids concentration in Colorado River below Hoover Dam as result of additional federal coal - 0.1 mg/l; any increase would be significant.	Dissolved solids increase below Hoover Dam as a result of additional federal coal - 0.5 mg/l: significant.	Dissolved solids increase below Hoover Dam as a result of additional federal coal - 0.6 mg/l : significant.
Air Quality	In the vicinity of towns, total suspended particulates would increase, but levels would diminish rapidly short distances from the towns. The same would be true for mines.	Annual total suspended particulates would exceed state standard of 45 ug/m^3 around some towns and mines, but would drop below that standard within 1 mile of the source.	See 1985.
	Non-methane hydrocarbons levels would exceed federal and state standards around mines, towns, and roads by virture of the baseline levels already exceeding those standards.	See 1980.	See 1980.
	Horizontal visibility would diminish around some towns, mines, and other point sources of particulates, but visibility would increase rapidly short distances from those sources.	See 1980.	See 1980.

TABLE 5-2 (Cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Soils	Surface disturbance: see Topography, 1980. Soil productivity would be permanently lost on soils permanently disturbed.	Surface disturbance: see Topography, 1985.	Surface disturbance: see Topography, 1990.
	Naturally developed soil horizons, structure, parent material, soil micro-climates, permeability and infiltration rates would all be lost or reduced on all disturbed soils.	See 1980.	See 1980.
	Loss of exposed soils by wind and water erosion; unquantifiable.	See 1980.	See 1980.
	Loss of soils due to ORV use: unquantifiable, but increases with population (see Recreation).	See 1980.	See 1980.
Vegetation	Removal of vegetation: see disturbance, Topography.	See 1980.	See 1980.
	Unavoidable temporary loss of production: 3,830 AUMs by 1980; of this, 350 AUMs due to additional federal coal.	Unavoidable temporary loss: 5,420 AUMs by 1985; of this, 1,510 AUMs due to additional federal coal.	Unavoidable temporary loss: 5,440 AUMs by 1990; of this, 1,860 AUMs due to additional federal coal.
	Permanent loss of production: 510 AUMs per year by 1980; of this 210 AUMs per year due to additional federal coal. Impact small and localized.	Permanent loss of production: 1,340 AUMs per year by 1985; of this, 640 AUMs per year due to additional federal coal. Impact small and localized.	Permanent loss of production: 1,660 AUMs per year by 1990; of this, 820 AUMs per year due to additional federal coal. Impact small and localized.
	Loss of vigor and diversity, successional stage. Toxicity of some reclaimed areas make revegetation impossible. Time to reestablish vegetative ecosystem would be 20 to 50 years.	See 1980.	See 1980.
	Overutilization of adjacent areas by wildlife and domestic fauna.	See 1980.	See 1980.
Animals			
Wildlife	No significant impacts on wildlife.	See 1980.	See 1980.
Domestic Fauna	For temporary and permanent loss of production, see Vegetation. Losses would be small and localized.	See 1980.	See 1980.
Aquatic Biology	Permanent loss of aquatic habitat due to disturbance of land - 165 acres by 1990; of this, 70 acres due to additional federal coal. Impact very minor.	Permanent loss of habitat: 435 acres by 1985; of this, 200 acres due to additional federal coal. Impact very minor.	Permanent loss of habitat: 540 acres by 1990; of this, 265 acres due to additional federal coal. Impact very minor.
Cultural Components			
Archeological Resources	Casual collection would result in loss or mixing of diagnostic data used to interpret interrelationships between prehistoric peoples and their environments. Not quantifiable.	See 1980.	See 1980.
	Loss of unidentified surface and buried sites where community expansion would occur. Not quantifiable.	See 1980.	See 1980.

TABLE 5-2 (Cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Cultural Components (cont.)			
Archeological Resources (Cont.)	Loss of paleoecological data on federal and non-federal leases. Not quantifiable.	See 1980.	See 1980.
	Loss or disturbance of recorded and unidentified surface or buried sites on lease sites and along rights-of-way on both federal and non-federal leases. Not quantifiable.	See 1980.	See 1980.
	Loss of archeological resources because of subsidence above underground mines. Not quantifiable.		
Historic Resources	Increased vandalism of historic sites as population would increase.	See 1980.	See 1980.
	Destruction of "historic atmosphere" in towns because of displacement of older structures by new construction.	See 1980.	See 1980.
Aesthetics	Impacts to landscape character: (1) support facilities for new population, (2) mining on steep terrain resulting in barren cut fill slopes, (3) surface facilities not blending with landscape, and (4) construction of roads, railways, and electric distribution lines on steep terrain or bedrock material contrasting with surrounding landscape.	See 1980.	See 1980.
	Dust, pollution, noise would adversely affect aesthetic quality of the area.	See 1980.	See 1980.
Recreation	Deficiencies in swimming and tennis opportunities in Routt and Moffat Counties.	See 1980.	See 1980.
	Minor increase in use of developed recreation sites in the study area.	See 1980.	See 1980.
	With disturbance of land for mining and ancillary construction (see Topography), loss of foot, ORV, and viewing opportunities. Subsidence could also be hazardous to these activities after reclamation.	See 1980.	See 1980.
	With increased population, increases in coliform levels on White and Yampa Rivers; Yampa could become ineligible for designation under Wild and Scenic Rivers Act. Also, possible curtailment or prohibition of water-contact sports.	See 1980.	See 1980.
Socio-Economic Environment	Influx of outsiders connected with additional development of federal coal would intensify long-term residents's sense of progressive erosion of traditional community values. New residents would feel alienated.	See 1980.	See 1980.
	As average earnings of workers would increase with new development, inflation would occur, reducing effective buying power, especially of those with low or fixed incomes.	See 1980.	See 1980.

TABLE 5-2 (Cont.)

SUMMARY TABLE OF ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

Environmental Element	Impacts 1980	Impacts 1985	Impacts 1990
Cultural Components (cont.)			
Socio-Economic Environment (cont.)	There would be deficiencies in public utilities and services and shortages in health care specialists and facilities and in housing.	See 1980.	See 1980.
Transportation Networks	With increase in population, increase in area's total hazard ratings at railroad crossings - 8.21 by 1980, 2.87 attributable to additional federal coal. Also, area's total daily vehicle waiting time for trains would increase to 17 minutes a day, 3 minutes of which would be due to additional federal coal.	Hazard ratings would increase to 8.30; of this, 3.60 due to additional federal coal. Vehicle waiting time would increase to 23 minutes, of which 8 minutes due to additional federal coal.	Hazard ratings would increase to 8.40; of this, 4.60 due to additional federal coal. Vehicle waiting time would increase to 23 minutes, of which 10 minutes due to additional federal coal.
	Roads designed for lighter traffic would receive heavy use due to transportation of coal; deterioration hastened (see Tables 1-3 through 1-6).	See 1980.	See 1980.
	Area's total accidents per year would increase as population increases - 2,450 by 1980; of these, 360 due to additional federal coal.	By 1985, 2,700 accidents per year in the study area, 400 of these attributable to additional federal coal.	By 1990, 3,000 accidents per year in the study area, 490 of these attributable to additional federal coal.

CHAPTER 6

RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

This chapter discusses the extent of long-term impairment or enhancement of resource values that would occur, given the short-term uses of the environment. In this analysis of trade-offs over time and trade-offs among resource values, short-term refers to that period when substantive parts of possible future mid-level development of federal coal would take place. Long-term refers to that period in which subsequent impacts, both adverse and beneficial, would still affect the environment after mining has ceased and reclamation has begun.

GEOLOGIC SETTING

Topography

The principal long-term effects of coal mining on topography would be subsidence from underground mining. The effects of subsidence should be minimal. No existing structures or public roadways would be threatened. There would also be minimal effects on surface drainage and ground-water. Topography of mined out areas would be restored to its approximate original contour.

Paleontology

Disturbance and destruction of paleontological resources would accompany the mining of coal. The exposure of these resources and survey of them could lead to some new knowledge, but much would be lost. Besides loss of the resources themselves, there would be a loss on context, which is important for interpretation. The loss of some resources would never be discovered because of the large scale of land distrubance. All of this would constitute a long-term loss of productivity regarding use of these resources.

MINERAL RESOURCES

The major impact to mineral resources would be the removal of a cumulative total 320.65 million tons of coal from the study area by 1990. This represents 0.8 percent of the 38 billion tons of measured, indicated, and inferred coal reserves in the study area (Landis 1959). Development of new federal coal at mid-level would account for 95.7 million tons of the total mined by 1990.

Approximately 130 millions tons of coal would not be recovered because of losses inherent in the method used to extract the coal. Approx-

imately 51 million tons of this unrecovered coal would be due to the new development of federal coal at mid-level. Underground mining would recover approximately 50 percent of the economically minable coal, surface mining methods approximately 90 percent of the economically minable coal.

The recovered coal would be used for short-term energy needs and would therefore not be available for future use.

WATER RESOURCES

The short-term use of the environment for coal production and other associated development would create a number of long-term impacts.

Aquifers would be removed from about 49.8 square miles by 1990 or about 0.56 percent of the study area. Aquifers removed by underground mining would not be replaced. Aquifers removed by surface mining would be replaced by spoil materials, which would have different hydrologic characteristics than the original aquifers.

Some springs may be permanently lost because of disturbances to local perched water conditions.

Leaching of spoil materials in surface-mined areas probably would increase dissolved solids concentrations locally to about 2,500 to 3,000 mg/l. This water would be suitable for use by livestock and wildlife but not for domestic purposes. Dissolved solids load in the Yampa River from leaching of spoil materials would probably average about 10,000 tons per year during the period 1978-1990 as a result of cumulative mid-level development.

All polluting sources associated with coal development would probably increase the weighted average of dissolved solids in the Yampa River by about 0.8 percent by 1990. The estimated increase in dissolved solids concentration in the Colorado River below Hoover Dam by 1990 would be about 0.6 mg/l. The discharge weighted average dissolved solids concentration below Hoover Dam is currently about 680 mg/l. The increase in load as a result of mining, therefore, would be about 0.09 percent.

Vertical cracks formed by subsidence associated with underground mining would open all intersected aquifers to intercirculation of ground water and equalization of hydraulic pressures. Upper perched zones may be drained, adversely impacting local wells and springs. Mixing of waters could locally degrade water quality in some aquifers.

All natural stream channels would be altered or removed from those areas where the surface is disturbed by mining or associated activities. Approximately 45.0 square miles would be disturbed by 1990. This is about 0.51 percent of the report area. Reconstructed channels must adjust to postmining flow conditions through processes of local

erosion and sedimentation. These processes are slow in ephemeral streams, which would comprise the bulk of those channels disturbed, and could take more than 50 years to reestablish approximate equilibrium.

Long-term erosion and sediment yield depends on the effectiveness of required mitigation measures. If those measures are generally effective as expected, no long-term erosion and sedimentation impacts would be anticipated.

AIR QUALITY

Degradation of air quality would accompany the mining of coal and the growth of population in the study area. While in operation, several of the major coal mines would exceed the prevention of significant deterioration (PSD) standards for total suspended particulates (TSP). Since certain fugitive dust emissions from mines are exempt from consideration against PSD standards, TSP levels would fall within legal limits. Non-methane hydrocarbon (NMHC) levels would exceed state standards in the vicinity of towns. In general, there would be an increase in the level of all pollutants, chiefly around isolated point sources (e.g., power plants) and around towns.

Coal development could also alter the micrometeorology of the mine sites by changing surface contours, albedo, and material distributions as well as temporarily reducing vegetation.

With cessation of mining, air quality would return to its previous baseline condition around mines. However, unless there is an appreciable decline in population in the study area accompanying decreases in mining activity, degradation of air quality would be long-term around towns. Moreover, if the labor force previously employed in mines would be reemployed in other sectors, new sources of industrial pollution could arise.

If reclamation and revegetation at mines would not approach equivalence with current vegetation and surface characteristics, local meteorology would be permanently altered.

SOILS

Because of short-term disturbance of soils that would occur with mining at mid-level, long-term productivity of soils on disturbed lands in the study area would decline. Soil development is a slow process under the best conditions; the semi-arid climate of most of the study area increases the time needed for soil development, thus magnifying the impact of short-term use on the long-term productivity of the area. Recovery would depend on climatic conditions and the success of reclamation procedures. Development of coal resources at mid-level would cause the temporary disturbance of 19,800 acres by 1990. Of this, 5,000 acres would be attributable to development of additional federal coal at mid-level. Revegetation would have taken place on 200 acres by 1980, an additional 5,160 acres by 1985, and an additional 7,310 acres by 1990 for a total of 12,670 acres,

but use of this land for forage and browse could be delayed 4 years from the beginning of reclamation (see Analysis Assumptions and Guidelines, Chapter 1).

Permanent loss of productivity due to mining activites, construction of ancillary facilites, and development of new housing would occur on 8,970 acres by 1990. Of this, development of additional federal coal would account for 4,410 acres.

As population increases with coal development, higher recreational demands such as off-road vehicle use would cause soil compaction in localized areas of use and increase soil loss (see Recreation). Soil loss from this source in the study area would be long-term, continuing as long as population associated with mid-level development remained. This soil loss is not quantifiable.

VEGETATION

Removal of vegetation associated with coal mining and with expansion of towns in the study area would have long-term impacts, chiefly the loss of production for grazing of livestock which could never be recovered. Permanent loss of production would be 1,660 AUMs per year by 1990. Of this, development of additional federal coal would account for 820 AUMs per year by 1990.

Loss of production would occur principally in southwest Routt County, southeast Moffat County, and the area northeast of Meeker in Rio Blanco County. Losses would accrue to individual landowners.

Loss of vegetation would also constitute loss of wildlife habitat (see Wildlife) and could change the climate in localized areas (see Air Quality).

ANIMALS

Wildlife

Mining and ancillary development would have long-term impacts on wildlife. There would be permanent loss of habitat resulting from new roads, power plants, railroads, and construction of housing to accommodate population growth. Habitat would be permanently lost on 8,970 acres by 1990. This represents only 0.20 percent of the entire study area.

Mined-out areas would be revegetated, but by 1990 none of the areas would be considered at carrying capacities comparable to habitat for existing wildlife communities. It would take 30 to 70 years to establish comparable habitat because the majority of plant species used to revegetate disturbed areas would constitute a floral composition different from what presently exists.

Every species of terrestrial fauna in the study area, listed in Appendix D (NWCCRES), would be affected by loss of habitat. The degree of impact would depend on the adaptability of the species involved and their mobility. Because of a lack of species density and composition data for the majority of wildlife species it is impossible to adequately estimate the reduction in carrying capacity for most non-game species that would result from mid-level development. Those species closely associated with sagebrush and mountain shrub habitat types would be the most severely impacted by coal development while species associated with grasslands would be adversely impacted during mining but beneficially impacted after revegetation (Appendix D, NWCCRES).

Loss of habitat would be most significant for game species such as elk, mule deer, antelope, and sage grouse. Loss of habitat would result in the loss of some animals, but this loss would not be significant. It would be small compared to the number of animals lost each year to car-animal collisions between Craig and the Wyoming border. Of the animals displaced, whether temporarily or permanently, 207 deer, 45 elk, and 52 sage grouse would be lost by 1990. Antelope losses would be negligible.

Population growth associated with mining would have long-term impacts on wildlife. Animal harassment would be expected to increase as more people spend their leisure time in the country, both on roads and in off-road vehicles, mainly snowmobiles. In addition, big game road kills would increase in the study area, to 1,250 animals per year in 1990. Despite loss of species from road kills, habitat disruption, and harassment, long-term losses due to development at mid-level would not be significant compared to total wildlife populations.

Domestic Fauna

Mining and related activites would affect the livestock industry of northwestern Colorado, principally through the increase in population associated with development of additional federal coal at mid-level. These effects would be long-term, continuing as long as that level of population remained. Rustling of livestock and damage to fences and other range improvement facilities would probably result from increases in human population and its use of the area. There are no estimates of these increases available, however, they are not expected to be significant.

Loss of production for grazing and livestock resulting from the removal of vegetation would be long-term. Permanent loss of production would be 1,660 AUMs per year by 1990. Of this, development of additional federal coal would account for 820 AUMs per year by 1990. This production could never be recovered.

Loss of production would occur principally in southwest Routt County, southeast Moffat County, and the area northeast of Meeker in Rio Blanco County. Losses would accrue principally to individual landowners.

The resulting decrease in livestock numbers could be significant to an individual livestock operator if the reduction of livestock numbers were a large enough percentage to affect the economics of the given livestock operation. This cannot be determined until coal mining boundaries are proposed.

Aquatic Biology

Long-term impacts to aquatic biology would result from population growth and developments ancillary to coal such as housing development, power plants, and railroads. These developments would result in a permanent loss of aquatic habitat due to disturbance of land - 540 acres by 1990. Disturbance due to development of additional federal coal would be 265 acres by 1990.

Population growth would result in water treatment facilities being progressively overloaded and therefore water quality being degraded below Craig, Hayden, Steamboat Springs, and Oak Creek on the Yampa River and below Meeker on the White River. This impact cannot be quantified because it cannot be predicted exactly what types of facilities would be constructed to treat waste.

Population growth would also create a direct loss of habitat from increases in agriculture-related activities. As more land would be allocated to agriculture to support additional population, domestic animals would damage already limited riparian habitat.

CULTURAL COMPONENTS

Archeological Resources

Loss of long-term productivity would occur as result of land disturbance, casual or scientific excavation, and vandalism. Loss of archeological sites would elimate data concerning the patterns and chronology of occupation and utilization in the study area and surrounding prehistoric cultural areas (Chapter 4). Sites to be excavated would preclude the use of data collection techniques which may be developed in the future. However, required intensive cultural surveys would find presently unknown resources; this identification and subsequent protection of significant resources would benefit future generations.

Historic Resources

During the short-term those sites that are not recorded, mitigated, or that are damaged by mining would be lost immediately and for future use and study. Long-term losses of historic resources would include slow deterioration of unprotected sites through weathering and vandalism (see Appendix A, Section 4).

The other long-term loss of historic resources would occur with the growth of population and the need for increased land and recreation opportunities. This in turn would cause the degradation of the "historic atmosphere" in the older section of such towns as Craig, Steamboat Springs, Meeker, and Oak Creek, and near certain historic areas such as Hahn's Peak, Colorado.

Aesthetics

Coal development at mid-level would alter visual resources for a long time. Disruption of land surface associated with mining would be extensive and would be highly visible where development would take place near highways and heavily used county roads. Accompanying air pollution and reduction in visibility would heighten the already adverse impacts to characteristic to outstanding scenery which often occurs in the area. This scenery could not be changed permanently.

Destruction of visual resources combined with adverse impacts to other environmental elements would wreak a change in the total character of the study area. This kind of change cannot be quantified. Widespread development around towns, congestion on roads and highways, and air pollution would adversely affect the aesthetics of the study area in a general way. This kind of change would tend to perpetuate itself and therefore be long-term.

Recreation

Some long-term losses of recreation opportunities would result when land would be permanently converted to other uses as a result of mining and ancillary development. By 1990 this would involve 8,970 acres of land, and would principally involve lands adjacent to centers of population - Craig, Hayden, Meeker, Steamboat Springs, and Oak Creek. These losses would accrue primarily to hiking, cross-country skiing/snowshoeing, backpacking, nature study, photography, ORV activites, horseback riding, collecting, camping, and picnicking. Wildlife viewing and hunting would also be affected. These losses, however, would be expected to be minor because of the vast recreation opportunities available in the study area.

There would be little or no long-term loss of wilderness values, since there is an abundance of wilderness opportunities in the study area.

Off-road vehicle use could increase with population, resulting in loss of mood-atmosphere qualities, vegetation, and soil and harassment of wildlife. Impacts related to ORV use are not quantifiable.

With increased population, there would be increased pressure on towns' sewage treatment facilities, which would lead to increased fecal

coliform levels in the Yampa and White Rivers. These increases could make the Yampa River ineligible for designation under the Wild and Scenic Rivers Act. This loss could be long-term, depending on how long the capacity of sewage facilities would be exceeded and how long it would take these rivers to recover.

Socio-Economic Environment

Coal development would inevitably have long-term impacts on the socio-economic environment in the study area. The influx of outsiders accompanying development would intensify long-term residents' sense of progressive erosion of traditional community values and loss of control over their destiny. The conflict of traditional values with those of new residents would wreak changes in both and these changes would tend to perpetuate themselves, particularly if people unemployed after the cessation of mining would find new employment in the area.

The loss of buying power due to inflation of prices for everything, including housing, would permanently affect everyone, but particularly those with low or fixed incomes.

Lack of sufficient health care specialists to accommondate the growing population would be likely to be long-term, because of the difficulty of attracting new specialists to an area that lacks a major health care facility.

There would also be the long-term loss of an intangible called quality of life. The character of the study area would change with development and population growth. This change in character would be manifest as the combined effects of adverse impacts detailed under various environmental components. Generally, there would be widespread development around towns to accommodate growing population, an increase in air pollution, possible polluting of rivers as sewage facilities are taxed to their limits, pressure on the capacities of various public facilities and services including education, and reduction in the quality of visual resources in the surrounding area. There would undoubtedly be an adjustment to these changes in the long-term, but until then, the stress of change would continue.

Transportation Networks

After mining of additional federal coal would cease, transportation needs associated with population would be long-term and would last as long as population associated with mid-level remained. Population would affect vehicle registrations, vehicle-miles traveled, accidents, auto-train collisions, average vehicle waiting time at railroad crossings. Any highway improvements or improvement in maintenance of roads which might occur during the heavy use indicated by 1990 would be benefits.

CHAPTER 7

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

This chapter quantifies those resources that would be consumed and permanently lost as a result of implementation of possible future federal actions at mid-level production. Such losses would be irretrievable commitments, i.e., once these resources were used, they could not be replaced.

GEOLOGIC SETTING

Topography

The only irreversible impact on topography would be minor surface cracking and settling that could occur from subsidence. The surface effects of subsidence would not be more pronounced than gullies and arroyos that are already characteristic of the study area.

Paleontology

The unavoidable loss of fossils at mid-level development would be irretrievable. Losses would involve the disturbance or destruction of plant, vertebrate, and invertebrate fossil localities, and impacts to an undetermined number of unexposed and exposed localities. Population increases would cause losses due to fossil collecting.

MINERAL RESOURCES

Coal

The major irreversible and irretrievable commitment of resources by mid-level mining activities would be the mining and consumption of coal. By 1990, 320.65 million tons of coal would have been mined in the study area. About 130 million tons of coal would not be recovered because of losses inherent in the methods used to extract the coal.

WATER RESOURCES

Ground Water

An irreversible or irretrievable commitment of ground water resources would occur with the local destruction of water-bearing beds due to mining (Chapter 4). The amount of this loss cannot be quantified, but probably would be small and localized. The increment

of ground water used by new population in the area would be essentially irretrievable as long as that population would remain.

Surface Water

The increment of surface water used by new population in the area would be essentially irretrievable as long as the population would remain. By 1990, this would amount to 4,790 ac-ft per year.

AIR QUALITY

The loss of clean, clear air during 1977-1990 due to coal development would be irretrievable. Total suspended particulates would exceed Class II standards and Colorado and federal air quality standards would be exceeded in areas of coal mining. Local emissions of particulates by the mines would irretrievably reduce visibilities around mines. However, these impacts would not be irreversible; air quality could be restored with cessation of mining.

Increased urbanization of the study area resulting from coal development would irretrievably increase ambient pollution concentrations. Impacts to air quality caused by urbanization would be reversible if population associated with coal development would move out of the region after mining has ceased.

SOILS

Soils removed for permanent developments would be lost. By 1990, 8,970 acres of land would be permanently affected.

VEGETATION

There would be an irreversible and irretrievable loss of vegetative production from the time land is temporarily disturbed until it is reclaimed. By 1990, 19,800 acres would have been temporarily disturbed. Of that, 12,670 acres would have been revegetated by 1990.

In addition, 8,970 acres of land would be out of production permanently by 1990 due to construction of shops and buildings around mines and housing development. This would constitute a loss of 1,660 AUMs per year by 1990.

ANIMALS

Wildlife

Habitat lost because of mining and related activities at mid-level would be small in relation to the total habitat available. There would be 8,970 acres of habitat irretrievably lost by 1990, which is 0.20 percent of the habitat available in the study area. Loss of animals due to displacement would also be extremely small in relation to total wildlife populations. Roadkills of big game animals would be 1,250 per year by 1990, but this too would be small in relation to total populations.

Domestic Fauna

Loss of AUMs for livestock forage would be irretrievable, but small and localized. By 1990, 14,970 AUMs would be lost due to temporary disturbance of land. An additional 1,660 AUMs per year would be lost due to lands permanently out of production.

Aquatic Biology

Loss of aquatic habitat due to mining and ancillary activities would be small. Most would occur as a result of housing development to meet demands of increased population. Total loss would be 540 acres by 1990. Population growth would also affect water quality in the Yampa River due to the overtaxing of sewage facilities, but the effect of this on the water resource cannot be quantified. Population growth would also create a direct loss of habitat due to increases in agriculture-related activities, but this cannot be quantified either.

Although all of these things would result in a permanent loss of aquatic habitat, no game fisheries would be affected, nor any threatened or endangered species.

CULTURAL COMPONENTS

Archeological Resources

Commitment of the area to coal development would result in an irreversible commitment of cultural resources, once mine plans would be approved and stipulations attached. The archeological sites found in these lease areas may not yield as much information as sites chosen according to research-oriented criteria. In addition, there are other factors which could adversely effect the quantity and quality of the data gathered. Where excavation is required, the immediate benefits are published information and physical data stored

for future comparison and study, but limited funding for excavation could limit or preclude ancillary studies which could yield paleo-ecological data. Total excavation would preclude the use of data collection techniques which may be developed in the future. Additional irreversible commitments of resources would be set in motion by growing population, which would result in a greater exposure of cultural resources to vandalism, casual collection and destruction or disturbance of cultural deposits.

Historic Resources

Any loss of historic resources including sites, structures, objects or the aesthetic value of a historic area that would be destroyed or disturbed by mining activity and associated development would be irreversible and irretrievable.

Aesthetics

Commitment to additional coal development would alter the visual resources of the study area. Disruption of land surfaces would be extensive and would be highly visible where development would take place near main highways and heavily used county roads. Accompanying air pollution and reduction in visibility would heighten the already adverse impacts to characteristic and outstanding scenery which often occurs in the study area. These visual resources could not be recovered through reclamation and their loss would be considered irretrievable.

Recreation

An irreversible and irretrievable commitment of recreational resources would be the loss of educational and viewing opportunities associated with archeological and historic resources (see Archeological Resources and Historic Resources) because these resources would be destroyed. Scenic viewing opportunities would also be irretreivably lost (see Aesthetics).

Socio-Economic Environment

Additional development of federal coal at mid-level would irretrievbly affect the intangible called "quality of life." This intangible is larger than the sum of individual adverse impacts which are irreversible and irretrievable.

The influx of population associated with development would adversely impact air quality and visual resources as a by-product of growth. Other aspects of crowding could affect quality of life. Public facilities and services would be taxed to their limits. Cost of housing would be irreversibly raised, although the extent of the increase would vary among individual counties. The cost of housing would never return to previous levels.

Rapid growth at mid-level would also inflate prices. This would irreversibly reduce the buying power of people with low or fixed incomes, particularly in Routt County. These losses of buying power during times of inflation would never be regained.

Traditional community values would be irreversibly altered with the influx of new people and lifestyles. This loss of quality of life would be irreversible. Confrontation among different value systems would cause alienation among people.

Transportation Networks

The only irreversible and irretrievable commitment of resources that would occur as a result of mid-level coal development would be the improvement of roads and highways and improvements to railroad facilities to accommodate increased traffic. These changes would be long-term benefits.

CHAPTER 8

ALTERNATIVE SCENARIOS

This regional study evaluates the impacts of projected coal development in northwestern Colorado. The production level evaluated as mid-level is dependent in part on future federal approval of mining and reclamation plans on existing federal leases and, in some cases, approval of short-term competitive leases under terms of the NRDC v. Hughes amended court order of June 14, 1978. However, the Secretary of the Interior is not proposing a particular production level for coal in this study area, nor does this report specifically propose any federal actions

Development of alternative sources of energy, energy conservation, federal development of the coal, and emphasis on coal development in other regions of the U.S. are more appropriate for consideration on a program rather than a regional basis. These evaluations were made in the previous coal programmatic statement and will be updated and revised as necessary in the new coal programmatic statement now in preparation.

A "best estimate" as to the mid-level level was used as a basis for evaluation of cumulative impacts from coal development with-in the study area. Actual production levels attained will depend on demand as well as availablility of the coal. Factors influencing production levels in this region include access and economics in relation to other coal sources, transportation, local and state as well as future federal approvals, and pollution control requirements and technology. As previously indicated, availability of the coal resource to meet market demands or production could well occur at a significantly lower or higher level than the identified mid-level. These alternative production scenarios are being evaluated to indicate areas of environmental concern or impact sensitivity.

Chapter 8 presents the lower and upper limits of coal development in northwestern Colorado. These limits, as described in Chapter 1, are called, respectively, the "low-level", and "high-level" scenarios. Each scenario contains a description of the level of development and its projected impacts by environmental component, paralleling the organization of Chapter 4. The environmental baseline conditions described in Chapter 2 and the rules and regulations defining mitigation in Chapter 3 are applicable generally to the low- and high-levels of coal development, with any exceptions noted.

LOW-LEVEL SCENARIO

The low-level scenario includes a cumulative analysis of impacts expected to occur through 1990 from continued development of private and state coal lands and federal coal leases with ongoing mining operations or federal coal leases that could be mined with a mine plan modification.

Table 8-1 shows the projected low-level coal production from federal and non-federal coal lands and Map 1-2 (Appendix C) shows the location of these existing and future mining operations. Table 8-2 shows the existing situation in 1977. Table 8-3 shows the projected cumulative development for the low-level above 1977 levels. Tables 8-4 and 8-5 give other detailed information associated with the low-level scenario, such as acres of disturbance and acres revegetated for mining, powerlines, railroads, increased population, etc. These data also are totals for existing development of private, state, and federal coal.

Production of the low-level was 7,404,100 tons in 1977 and is anticipated to be 16,595,000 tons by 1980, 18,195,000 tons by 1985, and 15,870,000 tons by 1990. The number of mines will increase from 12 in 1978 to 22 by 1980 and to 26 by 1985 and 1990. This increase is due primarily to private development.

Power plant capacity is anticipated to remain the same (1,210 megawatts) from 1980 through 1990. Railroad spurs constructed by 1980 will include the completion of the Colowyo Railroad spur, 2 miles of rail spur to market coal from the Hayden Gulch Mine, and 2 miles of railroad siding for Coal Fuel Corp.'s planned underground mine near the Hayden power plant.

By 1985 additional rail spurs will include approximately 15 miles from Energy West Inc.'s Sugar Loaf mine to the rail head in Craig.

There will be an 88-mile powerline from Rifle to Craig. This powerline is presently being constructed by the Colorado Ute Electric Association. Another powerline included in low-level development is that of White River Electric's 25-mile line from Meeker to the C-b oil shale tract. This line is already under construction.

TABLE 8-1

LOW-LEVEL COAL PRODUCTION IN THE STUDY AREA
(1000s OF TONS)

Company	1980		1985		1990	
	F	NF	F	NF	F	NF
AMCA	250	-	250	-	-	-
Coal Fuels Corp.	-	1,000	-	2,000	-	2,000
Colowyo	3,000	-	3,000	-	3,000	-
Empire Energy	-	2,400	-	2,400	-	1,800
Energy Fuels	1,750	-	-	-	-	-
Energy West Inc.	-	750	-	3,500	-	2,625
Milner Coal Corp.	-	500	-	500	-	-
Peabody Coal Co.	900	600	900	600	900	600
P & M	200	800	200	1,500	200	1,800
Rockcastle Co.	-	250	-	250	-	250
Northern Minerals	10	-	10	-	10	-
Sheridan Ent.	150	135	150	135	150	135
Sun Coal Co.	-	200	-	200	-	-
Sunland Coal Co.	100	-	-	-	-	-
Utah International Inc.	1,200	1,400	200	2,400	800	1,600
W.R. Grace	-	1,000	-	-	-	-
Subtotal	7,560	9,035	4,710	13,485	5,060	10,810
Total	16,595		18,195		15,870	

TABLE 8-2

EXISTING DEVELOPMENT OF PRIVATE, STATE, AND
EXISTING FEDERAL COAL (FOR LOW-LEVEL SCENARIO)

Activity of facility	1977
Number of new and existing mines	12
Power plant capacity (megawatts)	450
Tons of coal mined (1000s of tons)	7,404
Approximate population	25,929
Miles of powerline construction	110

TABLE 8-3

PROJECTED LOW-LEVEL DEVELOPMENT (PRIVATE, STATE, AND EXISTING FEDERAL COAL) ABOVE 1977 LEVELS AT 1980, 1985, and 1990.

Activity of facility	1980	1985	1990
Number of new mines	10	14	14
Power plant capacity (megawatts)	760	760	760
Tons of coal mined per year (1000s of tons)	9,191	10,791	8,466
Approximate population increase	800	11,600	13,200
Miles of new railroad	27	42.5	42.5
Miles of new road	10	30	55

TABLE 8-4

ACRES DISTURBED AND REVEGETATED AT LOW-LEVEL
(PRIVATE, STATE, AND FEDERAL COAL)

	1978-80	1981-85	1986-90	Total
Surface mines	2,810	5,280	4,830	12,920
Surface mines revegetated	100	2,810	5,280	8,190
Powerline rights-of-way disturbed	1,880	-	-	1,880
Powerline rights-of-way revegetated	-	1,880	-	1,880
Roads 1/ 2/	210	420	525	1,155
Surface mine 1/ facilities and related rights-of-way	700	200	-	900
Underground mines 1/ 3/ and related rights-of-way	120	200	-	320
Power plants 1/	-	-	-	-
Railroads 1/ 6/	490	275	100	865
Population 1/ 7/	80	1,080	160	1,320
Total Disturbed 5/	6,290	7,455	5,615	19,360
Total revegetated 4/	100	4,690	5,280	10,070
Total permanently removed	1,600	2,175	785	4,560

1/ This acreage considered permanently removed from production for the time frame of this report.
2/ Includes haul roads, access roads, and coal exploration trails.
3/ Does not include subsidence.
4/ Includes acreage revegetated from mine and powerline disturbance.
5/ The total disturbed acreage includes all those in footnote 1/ and acres disturbed from surface mines and powerlines.
6/ There are 18 acres per mile required for construction of a railroad (150' right-of-way).
7/ There are 100 acres required per 1,000 population increase.

TABLE 8-5

COAL PRODUCTION AT LOW-LEVEL IN NORTHWEST COLORADO 1/

Activity	Projected coal production (1000s of tons)			Total Acres of 2/ disturbance				Total Acres revegetated			
	1980	1985	1990	1978-80	1981-85	1986-90	Total	1978-80	1981-85	1986-90	Total
Activity on state and private coal lands and activity of ongoing or approved mines on federal leases	16,595	18,195	15,870	6,290	7,455	5,615	19,360	100	4,690	5,280	10,070

1/ Data listed for years 1980, 85, and 90 are for those specific years; Data listed for time periods 1978-80, 1981-85, and 1986-90 are cumulative for the indicated periods.
2/ Average acreage per year disturbed per million tons of coal mined equals 100 acres. This figure is for coal mines on the Wadge coal seam; mines with thicker seams or multiple seams will create less acreage disturbance per million tons of coal mined.
3/ Assume 100 ton capacity cars for all cars in a unit train with 80 cars per unit train.
4/ There is a requirement of 10 gallons of water per ton of coal produced.
5/ There is a requriement of 175 acre-feet/year of water per 1000 population increase.

TABLE 8-5 (Cont.)

COAL PRODUCTION AT LOW-LEVEL IN NORTHWEST COLORADO 1/

Activity	Permanent employment			Unit trains per year 3/			Annual water requirements 4/ for mine and coal handling (acre-feet/year)			Annual water requirements 5/ for population increase (urban) (acre-feet/year)		
	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990
Activity on state and private coal and activity of ongoing or approved mines on federal leases	1,565	2,200	2,110	1,660	1,820	1,590	510	550	490	130	1,950	2,220

1/ Data listed for years 1980, 85, and 90, are for those specific years; Data listed for time periods 1978-80, 1981-85, and 1986-90 are cumulative for the indicated periods.
2/ Average acreage per year disturbed per million tons of coal mined equals 100 acres. This figure is for coal mines on the Wadge coal seam; mines with thicker seams or multiple seams will create less acreage disturbance per million tons of coal mined.
3/ Assume 100 ton capacity cars for all cars in a unit train with 80 cars per unit train.
4/ There is a requirement of 10 gallons of water per ton of coal produced.
5/ There is a requirement of 175 acre-feet/year of water per 1000 population increase.

Topography

Long-term developments such as mine buildings and shop facilities, railroads, and housing developments would cause minor alterations to the topography in coal mining areas (southwest Routt County, southeast Moffat County and the area northeast of Meeker) and areas of population growth (Meeker, Oak Creek, Hayden, and Steamboat Springs). These changes are considered permanent for the time frame of this report. These disturbances would affect 1,600 acres by 1980, an additional 2,175 acres by 1985, and an additional 785 acres by 1990 for a total of 4,560 acres permanently disturbed by 1990.

Mining would result in temporary disturbances to the topography in the areas of coal mining. Existing natural surfaces would be replaced with man-made surfaces and artificial drains. Although this temporary disturbance would represent the greatest alteration of the topography it would only exist for the life of the mine. Temporary disturbance would occur over 4,690 acres by 1980, an additional 5,280 acres by 1985, and an additional 4,830 acres by 1990 for a total of 14,800 acres. Subsidence and related earth fractures, including a general lowering of the surface, opening of tension cracks, and formation of compression features such as fracture bulges and small anticlines, may occur above underground mines as a result of the removal of one or more coal beds. A further description of the nature of these changes appears in Chapter 4, Topography.

The magnitude of subsidence-related impacts and the area affected is difficult to determine. Most underground mining in the study area would utilize continuous underground room and pillar methods (Table 1-1). Some tension cracks would probably reach the surface, but no significant lowering of the surface during or following mining should occur. Subsidence as a result of the longwall method, which removes large blocks of coal and encourages roof collapse in the mined-out areas, may reach a few tens of feet, but should average less than 10 feet. Very little longwall mining is planned.

So far as could be determined, possible subsidence and related fracturing as a result of cumulative development at low-level would jeopardize no existing structures or public roadways. Any changes in topography should be subtle and have minimal effect on surface drainage. Cracks should fill rapidly with debris and sediment and should present no greater hazard to wildlife than existing steep-sided gullies or arroyos. The effects of subsidence on ground-water are described in Water Resources.

Paleontology

Impacts to paleontological resources would consist of losses of plant, inverterbrate, and vertebrate fossil materials for scientific research, public education (interpretive programs), and to other values. Losses

would result from destruction, disturbance, or removal of fossil materials as a result of coal mining activities, unauthorized collection, and vandalism.

A beneficial impact of development would be the exposure of fossil materials for scientific examination and collection which otherwise may never have occurred except as a result of overburden clearance and excavation.

Losses of paleontological materials due to unauthorized collecting and vandalism would increase as population increases, but no data exists to correlate losses with general population increase.

Losses to paleontological values due to coal-related operations would occur especially in the vertebrate fossil-bearing formations in areas of coal development. These values are mammalian and other vertebrate fossils of the Wasatch and Fort Union Formations, 5 to 10 miles west of Craig, Colorado, of the Fort Union and Lance Formations, 10 miles northeast of Craig, and other unspecified vertebrate fossils of the Bridger Formation, 5 to 10 miles south of Craig.

MINERAL RESOURCES

The major impact to mineral resources would be the removal of a cumulative total 224.68 million tons of coal from the study area by 1990. Coal production in the study area would be 16.6 million tons per year by 1980, 18.2 million tons per year by 1985, and 15.9 million tons per year by 1990. This represents 0.6 percent of the 38 billion tons of measured, indicated, and inferred coal reserves in the study area (Landis 1959).

Approximately 79 million tons of coal would not be recovered because of losses inherent in the method used to extract the coal. Underground mining would recover approximately 50 percent of the economically minable coal, surface mining methods approximately 90 percent.

Mineral resource conflicts may occur between development of coal and development of oil and gas, and to a lesser extent, uranium. Conflicts with oil and gas rarely occur, but result when resources occur at the same horizon; they would be based on superimposed occurrence of coal near the surface, and oil and gas at depth. Because these resources normally can be recovered sequentially without notable increase in environmental impacts over those occurring with separate recovery, the impacts of coal vs. oil and gas conflicts would be insignificant in a regional sense.

Potential conflicts between coal and uranium are not known at this time. Known occurrences of uranium, particularly in the Maybell area, are not co-extensive with coal nor attractive for development, and recovery would not jeopardize future recovery of coal. Increases in world demand and price for uranium, however, have accelerated exploration for uranium in northwestern Colorado, and new discoveries are possible. Chances are low that mining for one resource would jeopardize future mining of the other. Impacts of coal vs. uranium conflicts have not been quantified, but probably would be low. See Non Coal-Related Development, Chapter 1, for further discussion.

Impacts stemming from low-level development should be the same in kind as those described in Chapter 4 but of lesser magnitude roughly in proportion to the amount of coal production below cumulative mid-level rates.

Ground Water

The approximate areal extent of aquifers that would be removed at low-level development during the time frames indicated in this report and related data are summarized below.

TABLE 8-6

IMPACTS ON AQUIFERS AT LOW-LEVEL

	1978-80	1981-85	1986-90	1978-90
Approximate area of aquifers removed, in square miles (sq-mi)	6.4	14.1	13.5	34.0
Percent of total coal area disturbed at low-level development	0.6	1.4	1.3	3.3
Percent of study area disturbed at low-level development	0.07	0.16	0.15	0.38

Under low-level development, approximately 34 square miles of aquifers would be removed during the period 1978-90. The affected area comprises about 3.3 percent of the coal area and about 0.38 percent of the study area. During the same period stream channels would be altered or removed from an area of about 30.2 square miles. This is about 3.0 percent of the coal area and about 0.34 percent of the study area. Removal or alteration of such a small part of existing aquifers and stream channels should have no significant impact on the regional ground-water and surface-water systems. These actions, however, would alter the hydrologic system locally by interrupting premining ground-water flow, by degrading water quality through leaching of spoil materials, by increasing consumptive use of water, and by increasing erosion in disturbed areas and consequent sediment yield downstream. These impacts are the same as those described in Chapter 4, Water Resources; the number of areas affected would be smaller, however, in keeping with the lesser acreage disturbed at low-level development.

Surface Water

All natural stream channels would be altered or removed within those areas disturbed at low-level development. The percentage of stream channels affected during the time frames indicated in this study are listed in Table 8-7.

Disturbance of stream channels on only 0.34 percent of the study area by 1990 should not significantly impact the regional surface-water system. Local impacts related to alteration or removal of stream channels should be similar to those occurring under cumulative mid-level development.

Consumptive use of water by mining-related activities at low-level development and changes in water quality in the Yampa and Colorado Rivers are summarized in Table 8-8.

Degradation in water quality from leaching of replaced spoil materials in surface-mined areas would probably produce essentially the same local effects as at cumulative mid-level production, but fewer areas would be impacted. Dissolved solids load in the Yampa River attributable to this source would be expected to increase from about 1.8 percent of total load at present to about 2.4 percent by 1980, 2.1 percent by 1985, and 1.8 percent by 1990. The declining amounts of incremental increases from 1980 to 1990 would be attributed to ongoing reclamation of abandoned surface-mined areas where essentially bare rocky spoil piles readily absorb precipitation and runoff and consequently are subject to excessive leaching.

Estimated dissolved solids concentrations in the Yampa and Colorado Rivers at low-level development are summarized in Table 8-9. This small increase should have no significant impact on aquatic biology, consumptive uses, or water-treatment facilities within the study area, but would have a serious impact on Colorado River water, because the dissolved soilids load currently exceeds desirable limits.

Interruption of premining ground-water flow by dewatering of mines and by modification of flow patterns by replaced spoil materials would tend to lower water levels in wells adjacent to mines and dry up some springs. These effects, however, should be local and generally

TABLE 8-7

IMPACTS ON NATURAL STREAM CHANNELS

	1987-80	1981-85	1986-90	1978-90
Approximate total surface area disturbed at low-level development (sq-mi)	9.8	11.6	8.8	30.2
Percent of total coal area in which stream channels would be altered or removed at low-level development	1.0	1.2	0.9	3.0
Percent of study area in which stream channels would be altered or removed at low-level development	0.11	0.13	0.10	0.34

TABLE 8-8

EXISTING AND FUTURE CONSUMPTIVE WATER USE AND WATER QUALITY IN YAMPA RIVER SUBBASIN AT LCW-LEVEL DEVELOPMENT 1/

	Supply, consumption, and quality categories	Present	1980	1985	1990
1	Total undepleted supply (ac-ft) 2/	1,702,400	1,702,400	1,702,400	1,702,400
2	Consumptive use at low-level development				
3	Irrigation (ac-ft)	69,700 3/	69,700 3/	86,500 4/	88,000 5/
4	Reservoir evaporation (ac-ft)	9,300 6/	9,300 6/	49,300 7/	54,300 8/
5	Riparian vegetation (ac-ft)	18,000	20,400	20,800	21,200
6	Power plants (ac-ft)	6,800	18,200 9/	18,200 9/	18,200 9/
7	Municipal and rural (ac-ft) 10/	1,500	1,500	2,100	2,200
8	Export from basin (ac-ft) 11/	10,600	10,600	10,600	10,600
9	Existing mines (ac-ft)	200	500	600	500
10	Net discharge at low-level development (ac-ft) 12/	1,586,300	1,572,200	1,514,300	1,507,400
11	Water quality (polluting sources) at low-level development				
12	Natural sources (tons)	335,000	335,000	335,000	335,000
13	Irrigation (tons)	80,000	80,000	98,000	100,000
14	Municipal wastes (tons) 13/	800	800	1,100	1,200
15	Existing mines (tons)	7,500	10,000	9,000	8,000
16	Less load due to power plants and exports (tons)	-2,900	-5,400	-5,400	-5,400
17	Dissolved solids in Yampa River (tons) (lines 12 through 16)	420,400	420,400	437,700	438,800
18	Discharge weighted average of dissolved solids in Yampa River at low-level development (mg/l)	194.9	196.7	212.6	214.1
19	Increase in dissolved solids in Colorado River below Hoover Dam at low-level development (mg/l) 14/	0 15/	1.0	6.4	7.0

1/ Update from Table RII-7, NWCCRES

2/ Irons and others, 1965.

3/ 71,400 - (2,390 x 0.7) = 69,700.
71,400 ac-ft = 102,000 ac x 0.7 (ac-ft water applied per acre).
2,390 = irrigated acreage on Vermillion Creek (from Division of Water Resources).

4/ 86,500 = 69,700 + (24,000 x 0.7).
24,000 = estimated increase in irrigated land.

5/ 88,000 = 86,500 + 1,500.
1,500 = estimated increase in irrigation water consumption due to Juniper Reservoir.

6/ From CWCB & USDA, 1969.

7/ 49,300 = 9,300 + 40,000
Juniper Reservoir: 33,000 ac-ft.
Savery - Pot Hook Reservoir: 7,000 ac-ft.

8/ Increase due to Cross Mountain Reservoir: 5,000 ac-ft.

9/ Increase in evaporation when Craig 1 and 2 come on line.

10/ Based on use of 150 gal/day/person with 50 gal/day consumed and 100 gal/day returned to streams as sewage. Population projections from Table 1-5.

11/ Transbasin diversions from Little Snake River drainage to Hog Park Creek (North Platte River Basin) and from Bear River Drainage to Egeria Creek (Colorado River Basin).

12/ No action other than power plants under construction.

13/ Based on 100 gal/sewage/day/person and increase in dissolved solids load of 200 mg/l.

14/ Includes both the effects of diversions and increased dissolved solids loading.

15/ Present is assumed to be base level against which future changes are compared.

TABLE 8-9

DISSOLVED SOLIDS IN THE YAMPA AND COLORADO RIVERS AT LOW-LEVEL

Increments of change	1980	1985	1990
Estimated increase in dissolved solids concentration in Yampa River at low-level development from all sources (mg/l)	1.8	17.7	19.2
Estimated increase in dissolved solids concentration in Yampa River attributable to mining and related activities at low-level development (mg/l)	1.8	1.6	1.1
Percent increase in dissolved solids concentration in Yampa River attributable to mining and related activities at low-level development	0.9	0.8	0.5
Estimated increase in dissolved solids concentration in Colorado River attributable to mining and related activities at low-level development (mg/l)	0.8	0.8	0.7
Percent increase in dissolved solids concentration in Colorado River attributable to mining at low-level development	0.12	0.12	0.10

short-term. The top of the zone of saturation should return to approximate premining levels following completion of mining. Restoration of locally perched ground-water conditions, however, would be difficult and probably would be only partially effective in reestablishing premining conditions. As a result, some springs may be permanently lost. Although no complete inventory of wells and springs is available for the study area, low-level development would probably adversely impact somewhat less than 1 percent of existing water supplies.

Degradation in water quality would occur from leaching of replaced spoil materials in surface-mined areas and from intercirculation of ground waters between aquifers connected by permeable spoil materials or by vertical fracturing associated with underground mining. The effects would be long-term and probably would increase dissolved solids concentrations locally to about 2,500 to 3,000 mg/l. This water would be suitable for use by livestock and wildlife but not recommended for domestic use. Dissolved solids load in the Yampa River from this source would probably decrease from about 10,000 tons/year in 1980 to about 8,000 tons/year by 1990 as abandoned surface-mined areas are reclaimed and excessive leaching of bare spoil piles is reduced. Municipal wastes, coupled with the above sources of pollution, would increase the weighted average of dissolved solids in the Yampa River by about 0.5 percent by 1990. This small increase should have no significant impact on aquatic biology, consumptive uses, or water treatment facilities within the study area. The corresponding increase in dissolved solids concentration in the Colorado River below Hoover Dam of about 0.7 mg/l by 1990 (Table 8-9), however, is considered to be significant, even though it represents an increase of only 0.10 percent.

Water losses from interception of runoff and storage water in impoundments and sedimentation ponds will be minor, probably averaging less than 0.01 percent of total runoff from the study area. Consumptive use of water as a result of low-level development is expected to reduce total water yield from the study area by about 7.6 percent by 1980, increasing to about 11 percent by 1985, and 11.4 percent by 1990. This reduction in total runoff as a result of low-level development should have no significant impact on the study area, which normally produces runoff far in excess of water needs. Local water rights are protected by regulations (Chapter 2, Water Resources). Any reduction in flow downstream into the Colorado River system, however, would reduce the amount of water available to the water-deficient Lower Basin States and must be regarded as a significant impact to these states.

Estimated sediment yields as a result of mining and associated activities at low-level are listed in Tables 8-10, 8-11, and 8-12. Results indicate that sediment yield from all disturbed areas would be larger than before disturbance at low-level by about 57 percent during 1978-80, about 67 percent during 1981-85, and would be about 36 percent less than normal during 1986-90. The above changes in sediment load would not be measurable in the Yampa River using normal sampling procedures and should have no impact on the river or its aquatic biology. Any increase in sedimentation in impoundments on the Colorado River would reduce their useful life minimally and should be a minor impact.

TABLE 8-10

ESTIMATED SEDIMENT YIELD AS A RESULT OF MINING AND ASSOCIATED ACTIVITIES AT LOW-LEVEL DEVELOPMENT
1978-80

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines	2,810	660	23	- 637
Surface mine facilities and related R/W 1/	700	160	6	- 154
Underground mines and related R/W 1/	120	30	1	- 29
Power lines	1,880	440	700	+ 260
Power plants	0	0	0	0
Roads	210	50	315	+ 265
Railroads	490	110	1,030	+ 920
Population related disturbances	80	20	240	+ 220
Total	6,290	1,470	2,315	+ 845
Net change from cumulative mid-level development (-) decrease (+) increase	-1,610	- 370	-2,305	-1,935

1/ R/W, rights-of-way.

TABLE 8-11

ESTIMATED SEDIMENT YIELD AS A RESULT OF MINING AND ASSOCIATED ACTIVITIES AT LOW-LEVEL DEVELOPMENT
1981-85

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines, new	5,280	2,060	72	-1,988
Surface mines, existing	2,810	1,100	38	-1,062
Surface mine facilities, new	200	80	3	- 77
Surface mine facilities, existing	700	270	10	- 260
Underground mines, new	200	80	3	- 77
Underground mines, existing	120	50	2	- 48
Power lines, new	0	0	0	0
Power lines, existing	1,880	730	940	+ 210
Power plants, new	0	0	0	0
Power plants, existing	0	0	0	0
Roads, new	420	160	1,050	+ 890
Roads, existing	210	80	210	+ 130
Railroads, new	275	110	960	+ 850
Railroads, existing	490	190	240	50
Population related disturbances, new	1,080	420	5,400	+4,980
Population related disturbances, existing	80	30	15	- 15
Total	13,745	5,360	8,943	+3,583
Net change from cumulative mid-level development (-) decrease (+) increase	-5,965	-2,310	-7,798	-5,488

TABLE 8-12

ESTIMATED SEDIMENT YIELD AS A RESULT OF MINING AND ASSOCIATED ACTIVITIES AT LOW-LEVEL DEVELOPMENT
1986-90

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines, new	4,830	1,890	66	-1,824
Surface mines, existing	8,090	3,160	110	-3,050
Surface mine facilities, new	0	0	0	0
Surface mine facilities, existing	900	350	12	- 338
Underground mines, new	0	0	0	0
Underground mines, existing	320	120	4	- 116
Power lines, new	0	0	0	0
Power lines, existing	1,880	730	940	+ 210
Power plants, new	0	0	0	0
Power plants, existing	0	0	0	0
Roads, new	525	210	1,310	+1,100
Roads, existing	630	250	630	+ 380
Railroads, new	100	40	350	+ 310
Railroads, existing	765	300	380	+ 80
Population related disturbances, new	160	60	800	+ 740
Population related disturbances, existing	1,160	450	225	- 225
Total	19,360	7,560	4,827	-2,733
Net change from cumulative mid-level development (-) decrease (+) increase	-9,410	-3,690	-5,255	-1,565

The emissions sources at low-level would be existing coal mines and their associated future development, major point sources, towns, and highways. Emission of particulate matter (PM), sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), and non-methane hydrocarbons (NMHC) from mines, towns, and highways were determined using the assumptions and methods of Chapter 4, Air Quality. Emissions from major point sources modeled for low-level were obtained from the same data sources as appear in Chapter 4.

Particulate emissions from mining of coal in the study area for low-level would be 13,321 tons per year by 1980, 12,249 tons per year by 1985, and 10,130 tons per year by 1990.

Major point sources modeled for low-level consist of the Hayden Power Plant, Units 1 and 2; the Craig Power Plant, Units 1 and 2; a rotary drier; and petroleum storage tanks. Emissions of the various pollutants for these sources are listed in Table 8-13. Emissions from the towns for the low-level scenario are shown in Table 8-14.

Region-wide emissions for the roads modeled for low-level are shown in Table 8-15. The road segments modeled for low-level are the same segments used for mid-level, shown on Map 4-10.

Emissions from railroad serving coal mines in the study area were not quantified or modeled. Fugitive dust emissions from construction of additional lines should be small and have no significant effect on regional total suspended particulates (TSP) concentrations. In addition, emissions from trains would be intermittent and the impact is expected to be site-specific.

Oil shale tracts C-a and C-b are in the White River Valley dispersion sub-area. Emissions from these major sources would not interact with emissions from coal-related developments in the study area and therefore were not included in the air quality modeling.

Since there are no proposals to develop uranium, oil shale, or geothermal resources in the study area before 1990, they are not included in the air quality modeling.

Resultant Air Quality and Climate

The impacts of both existing coal mining activities and all other activities in the study area are compared to the national and Colorado ambient air quality standards and to the established criteria for prevention of significant deterioration (PSD) of air quality.

Significant existing and future sources of pollutants in the study area at low-level include towns, highways, mines, major point sources, and rural baseline levels of pollutants.

TABLE 8-13

EMISSIONS FROM MAJOR POINT SOURCES IN THE STUDY AREA
FOR LOW-LEVEL (TONS/YEAR)

Source	Pollutant	Emissions 1980	1985	1990
Hayden Power Plant				
Unit #1	Particulates	260	260	260
	SO_2	5,680	5,680	5,680
	NO_x	5,730	5,730	5,730
	CO	318	318	318
Unit #2	Particulates	388	388	388
	SO_2	8,480	8,480	8,480
	NO_x	8,551	8,551	8,551
	CO	475	475	475
Craig Power Plant				
Unit #1	Particulates	1,082	1,082	1,082
	SO_2	5,567	5,567	5,567
	NO_x	10,825	10,825	10,825
	CO	771	771	771
Unit #2	Particulates	1,082	1,082	1,082
	SO_2	5,567	5,567	5,567
	NO_x	10,825	10,825	10,825
	CO	771	771	771
Asphaltic Concrete Rotary Drier (east of Craig)	Particulates	339	339	339
Amoco Petroleum Storage Tanks (12 miles south of Craig)	NMHC	398	398	398

TABLE 8-14

POLLUTANT EMISSIONS FROM TOWNS IN THE STUDY AREA
FOR LOW-LEVEL (TONS/YEAR)

Town	Pollutant	1980	1985	1990
Craig	PM	27	37	39
	NO_x	207	295	311
	CO	1,757	2,493	2,642
	NMHC	336	477	506
Steamboat Springs	PM	42	60	71
	NO_x	306	428	515
	CO	1,705	2,393	2,880
	NMHC	400	561	675
Meeker	PM	64	120	110
	NO_x	422	790	719
	CO	2,277	4,268	3,884
	NMHC	500	936	853
Rangely	PM	29	59	54
	NO_x	189	390	359
	CO	1,021	2,103	1,937
	NMHC	224	461	426
Hayden	PM	15	22	28
	NO_x	110	158	202
	CO	616	883	1,127
	NMHC	144	206	264
Oak Creek	PM	5	9	12
	NO_x	34	63	85
	CO	191	355	473
	NMHC	45	83	111

TABLE 8-15

VEHICULAR EMISSIONS FOR ROADS IN THE STUDY AREA
FOR LOW-LEVEL (TONS/YEAR)

	PM	NO_x	CO	NMHC
1980	1,875	1,322	14,399	1,533
1985	1,995	1,093	7,879	661
1990	2,136	1,045	4,285	329

Annual average TSP concentrations are shown on Maps 8-1 through 8-3. Coal development would not cause any significant regional increases in TSP.

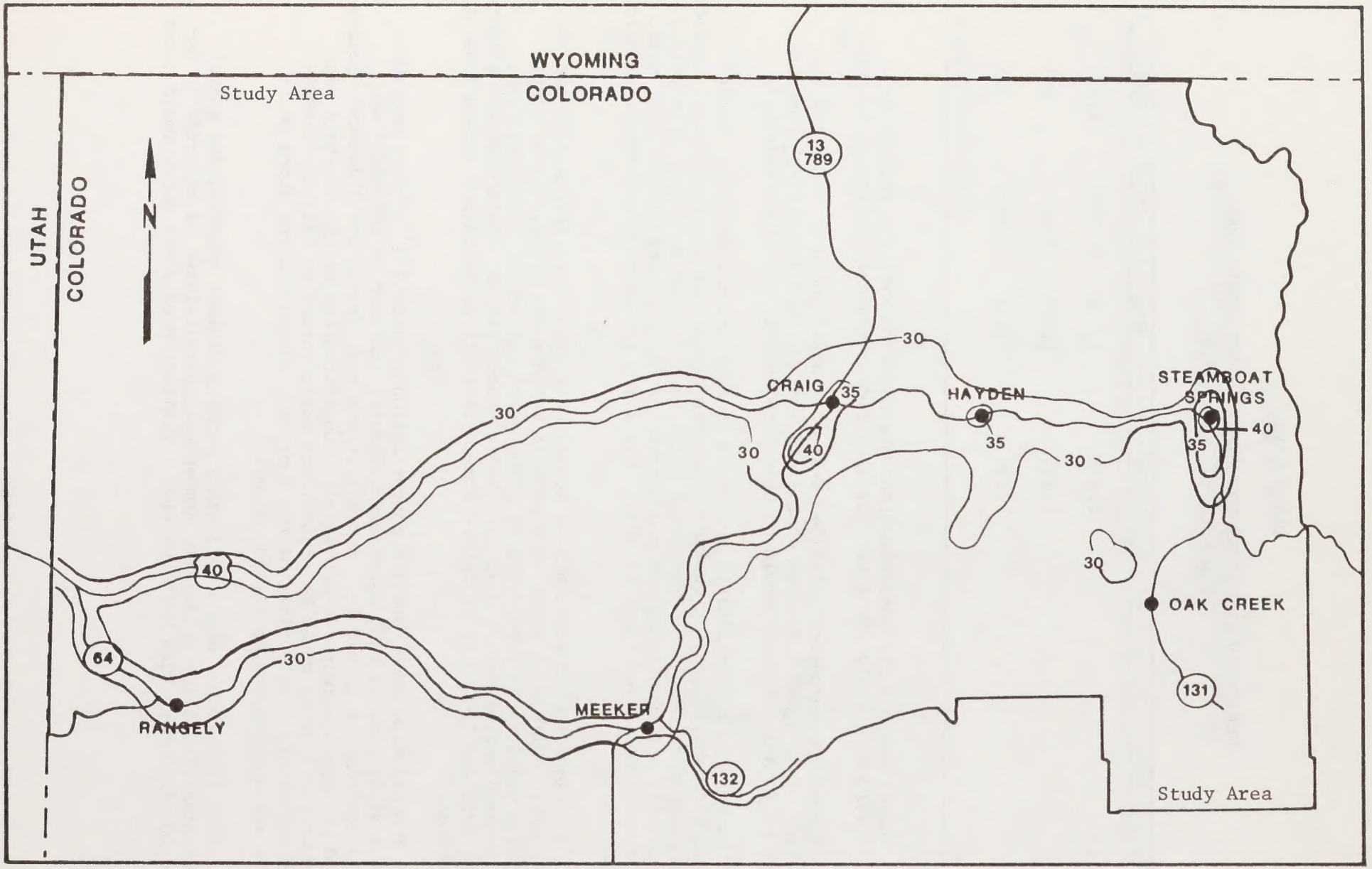
Annual SO_2 concentrations (Map 8-4) of 5 ug/m^3 would be far below the standard of 80 ug/m^3. Maximum short-term (24-hour and 3-hour) SO_2 concentrations of 40 and 250 ug/m^3 would be below the federal and state standards.

Annual NO_2 concentrations are shown on Maps 8-5 through 8-7. Power plants and vehicle traffic would be the main sources of NO_x emissions. Region-wide concentrations of 5 ug/m^3 would occur over much of the study area during 1980, 1985, and 1990. Maximum concentrations of approximately 15 ug/m^3 would occur near the larger towns by 1990. These are far below the federal standard of 100 ug/m^3.

The highest CO concentrations would occur around the larger towns in the study area. Within 1½ miles of Steamboat Springs and Craig, 8-hour concentrations would range from 4,200 to 4,400 ug/m^3 and 1-hour concentrations would reach approximately 7,100 in 1980. Concentrations would decrease slightly by 1985 and 1990. These short-term concentrations would not exceed federal standards.

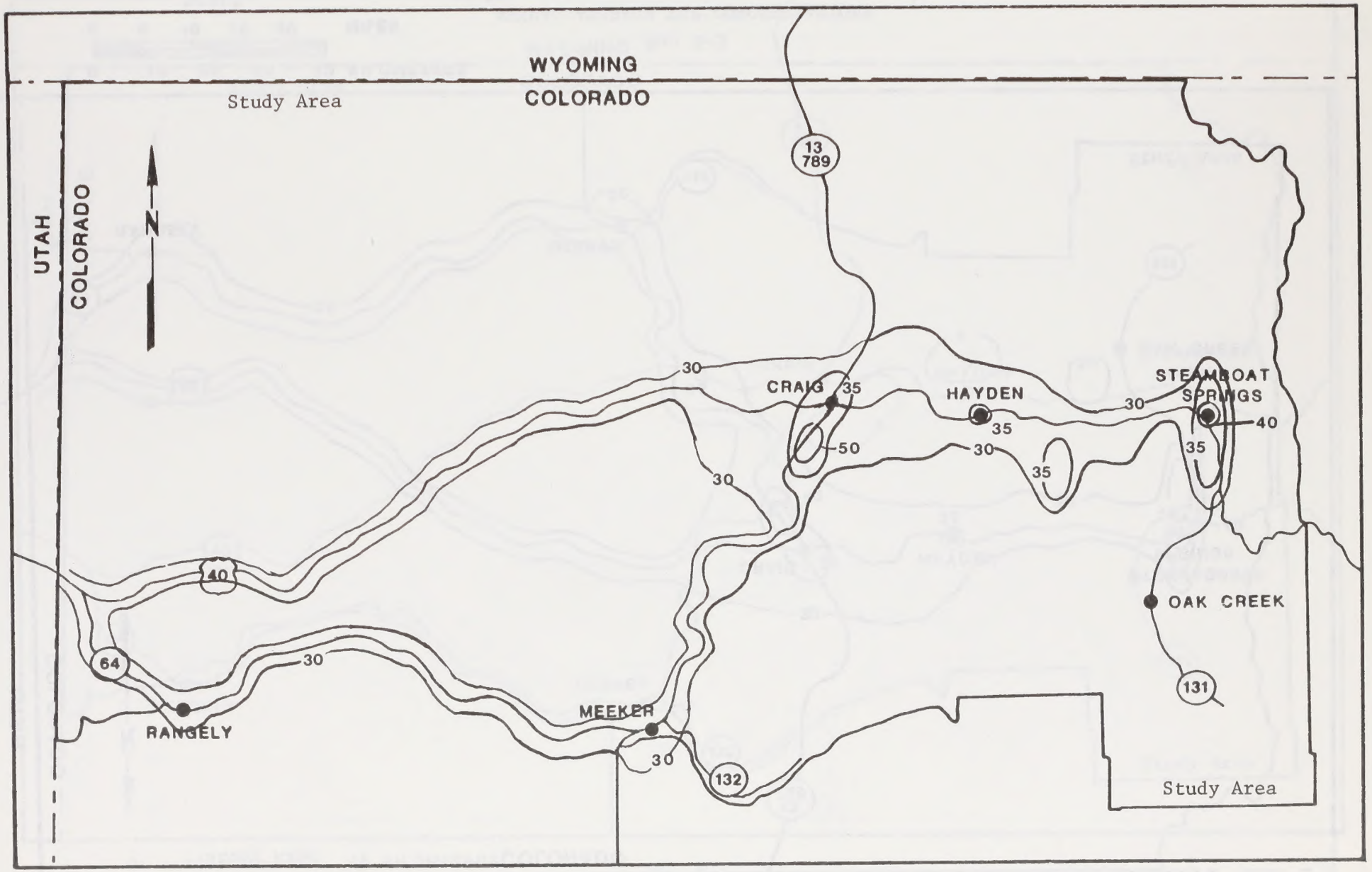
The existing NMHC baseline concentration of 446 ug/m^3 (3-hour average) in the study area already exceeds the federal standard of 160 ug/m^3 and would continue to exceed it. Concentrations near Craig, and Steamboat Springs would be approximately 550-600 ug/m^3. Concentrations within one-half mile of specific sources would be higher, but would return to baseline concentrations within 7 to 9 miles of the sources. Concentrations along major roads would be approximately 500 ug/m^3.

Away from towns, mines, and other major pollutant sources, the annual horizontal visibility related to atmospheric particulates is expected to exceed 50 miles more than half the time. Visibility of 20-25 miles would occur



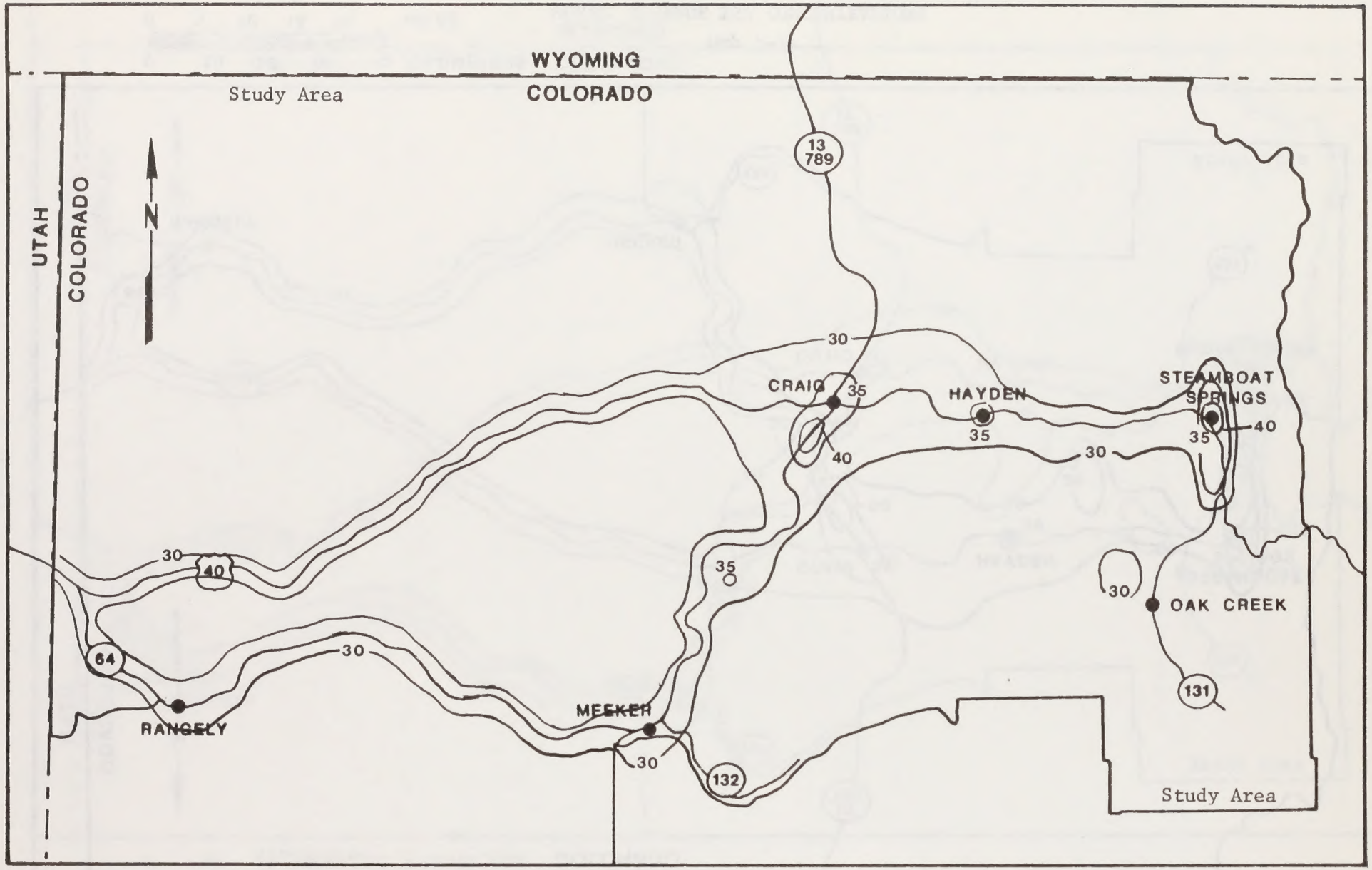
Map 8-1

ANNUAL AVERAGE TSP CONCENTRATIONS
IN 1980 FOR THE LOW LEVEL SCENARIO ($\mu g/m^3$)



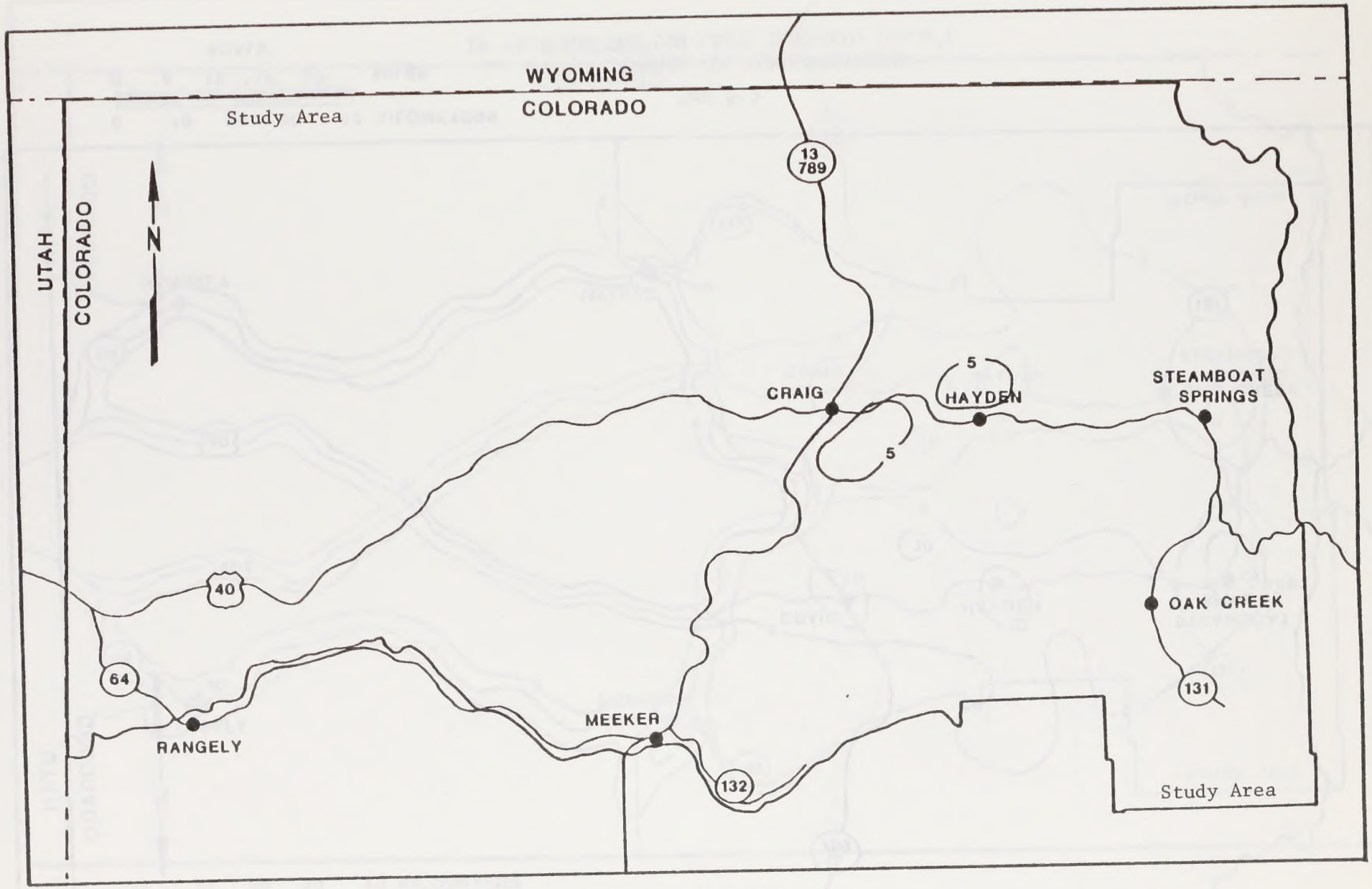
Map 8-2

ANNUAL AVERAGE TSP CONCENTRATIONS
IN 1985 FOR THE LOW LEVEL SCENARIO ($\mu g/m^3$)



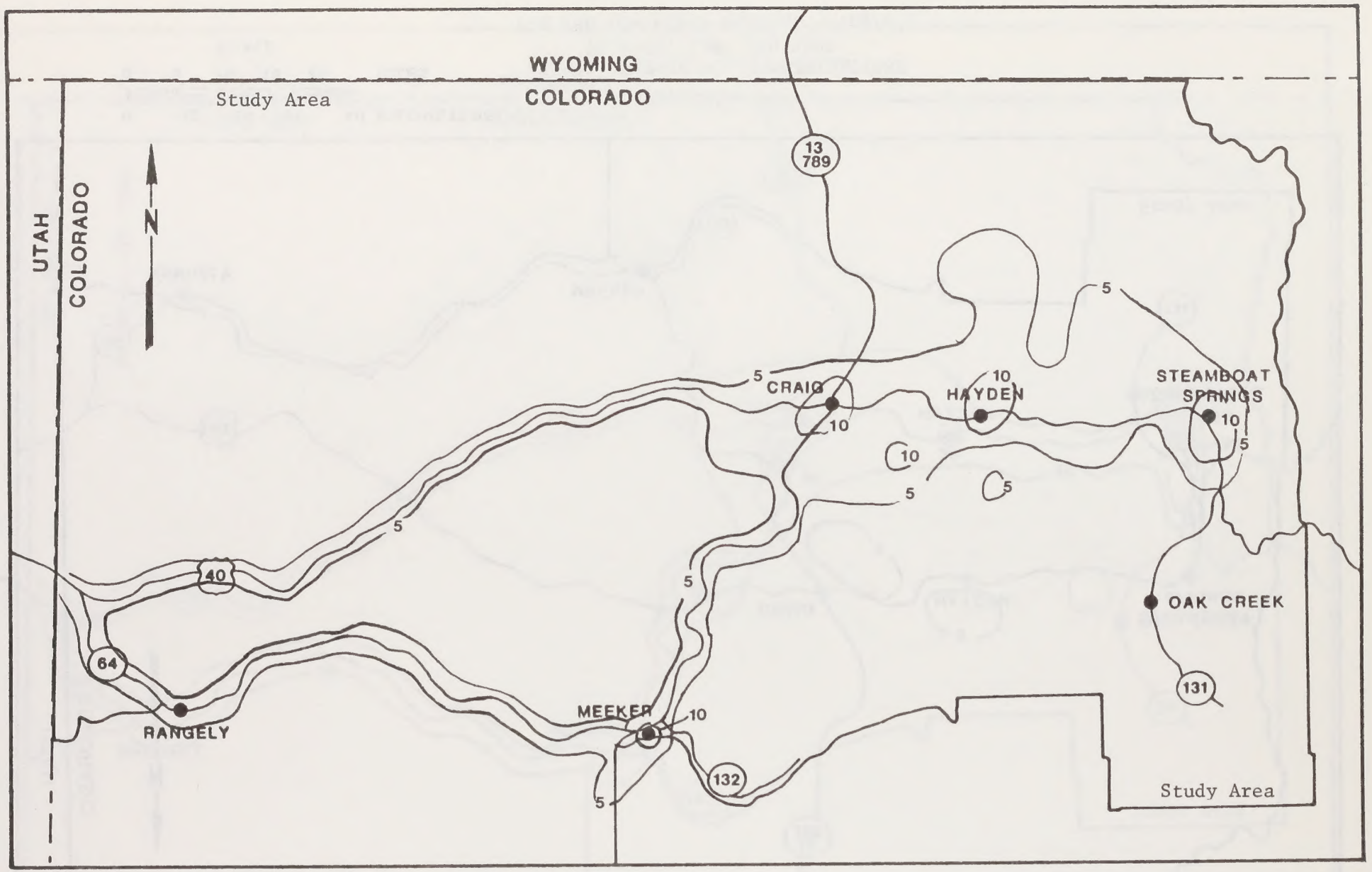
Map 8-3

ANNUAL AVERAGE TSP CONCENTRATIONS
IN 1990 FOR THE LOW LEVEL SCENARIO ($\mu g/m^3$)



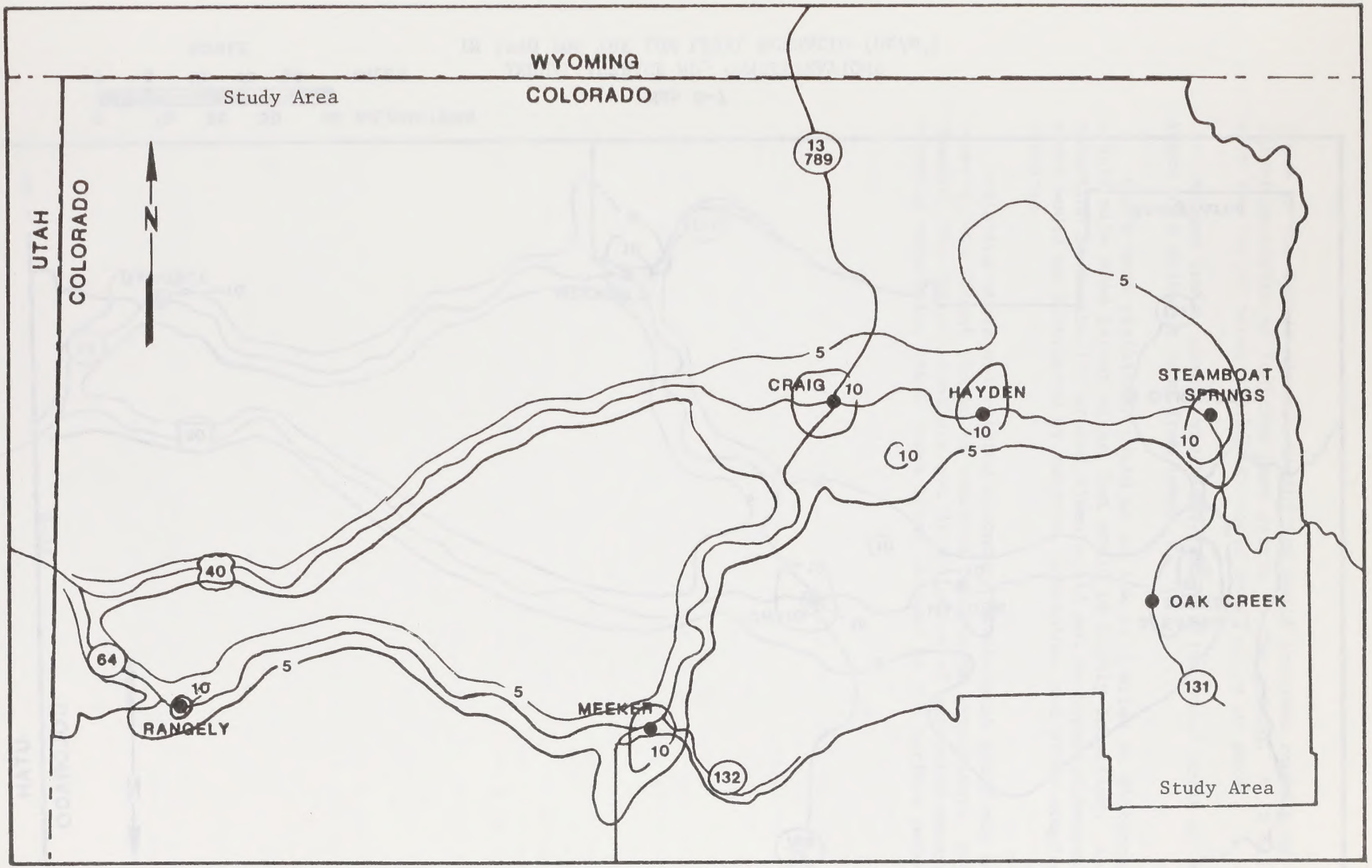
Map 8-4

ANNUAL AVERAGE SO_2 CONCENTRATIONS
IN 1980, 1985 AND 1990
FOR THE LOW LEVEL SCENARIO ($\mu g/m^3$)



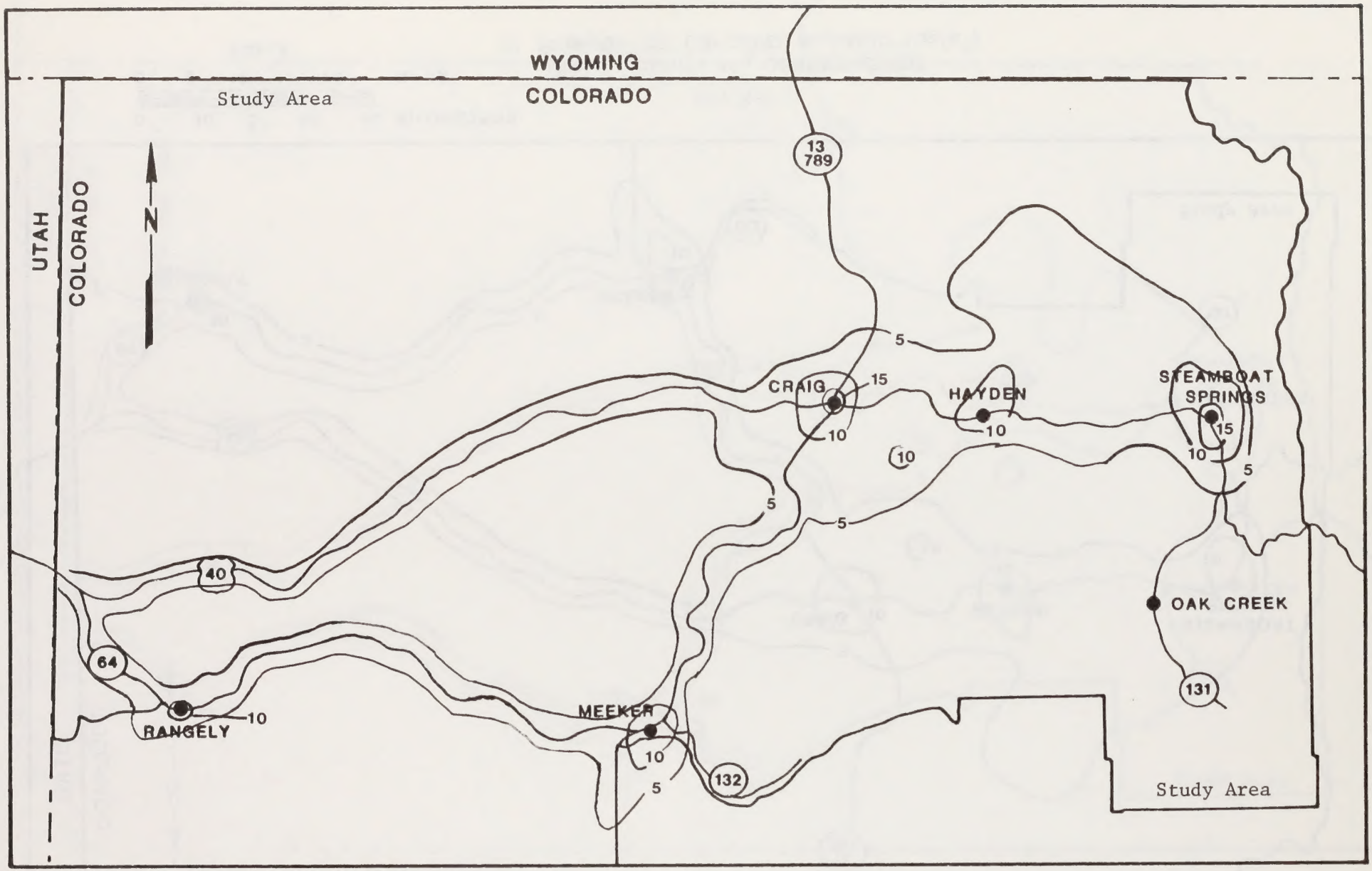
Map 8-5

ANNUAL AVERAGE NO_2 CONCENTRATIONS
IN 1980 FOR THE LOW LEVEL SCENARIO ($\mu g/m^3$)



Map 8-6

ANNUAL AVERAGE NO_2 CONCENTRATIONS
IN 1985 FOR THE LOW LEVEL SCENARIO ($\mu g/m^3$)



Map 8-7

ANNUAL AVERAGE NO_2 CONCENTRATIONS
IN 1990 FOR THE LOW LEVEL SCENARIO ($\mu g/m^3$)

close to the larger mines. Visibility would increase rapidly as the larger particles of fugitive dust settle to the ground. At 2 miles from even the larger mines visibility would be 35 miles or more.

Around Craig, annual visibility of 45 miles could occur at a distance of 8 miles or less from town.

Short-term visibility could be as low as 7 miles at distances of about a half mile from larger mines, but would be highly localized. In many cases, reduction in visibility around mines would not be apparent because lines of sight would be obstructed by canyons, mountains, and other complex terrain features.

Existing mines and related secondary development would not be expected to cause a significant change in regional climate or meterology. However, changing the surface contours and distribution of extracted materials and removing vegetation could cause local changes in the surface meteorology.

Impacts from low-level would be of the same kind as discussed in Chapter 4, Soils. There would be some permanent loss of soil productivity, loss of natural soil integrity, potential soil loss and mixing from unpredictable wind and water action, soil loss from increased recreational demands, and short-term reduction in soil productivity.

Surface disturbance at low-level would be 6,290 acres from 1978-80, 7,455 acres from 1981-85, and 5,615 acres from 1986-90, totaling 19,360 acres by 1990. Surface mining at low-level would disturb 2,810 acres from 1978-80, 5,280 acres from 1981-85, and 4,830 acres from 1986-90, totaling 12,920 acres by 1990. At low-level, ancillary development and increased urbanization would disturb 3,480 acres from 1978-80, 2,175 acres from 1981-85, and 785 acres from 1986-90, totaling 6,440 acres by 1990.

Loss of soil productivity from ancillary low-level development (mine facilities, railroads, and increased urbanization excluding powerlines) would be 1,600 acres during 1978-80, 2,175 acres during 1981-85, and 785 acres during 1986-90, totaling 4,560 acres by 1990.

Loss of natural soil properties and creation of new soil complexes would be unavoidable on all disturbed areas. Soil loss and mixing may result from the unpredictable nature of wind and water action on disturbed soils. OSM regulations (715.16(a)(b)) should minimize soil loss by requiring protection of topsoil through revegetation and/or mulching. Due to the unpredictable nature of high intensity rainstorms, all soil in all disturbed areas would be susceptible to on-site erosion and mixing in required sediment ponds (see Water Resources). Those required sediment ponds would confine erosion to the mine site, with possible mixing of the various disturbed soils materials affecting topsoil quality. Soil loss by wind and water from new housing developments and other urbanization, totaling 1,370 acres by 1990, would be unmitigated. The amount of this soil loss and loss of soil productivity cannot be predicted.

With increased off-road vehicle use (see Recreation) resulting from population growth at low-level there would be localized compaction and soil loss, but this is not quantifiable in the study area.

The short-term reduction of soil productivity would result from surface mining and powerline construction until disturbed areas would be reclaimed and capable of supporting vegetation consistent with post-mining land use (see Vegetation). Short-term reduction in soil productivity at low-level would affect 4,690 acres during 1978-80, 5,280 acres during 1981-85, and 4,830 acres during 1986-90, totaling 14,800 acres by 1990.

Soil disturbance would occur around areas of coal development (southwest Routt County, southeast Moffat County, and the area northeast of Meeker) and areas of population growth (Meeker, Oak Creek,

Hayden, and Steamboat Springs). Soils affected in the study area are indicated on Map 1-2, Appendix C, location of mines for low-level, and Foldout 8, Appendix B, NWCCRES, General Soil Map. Descriptions of soil associations including their characteristics and reclamation potentials appear in Table 2-21. The soil associations expected to be affected at low-level coal development are #59, #62, #21, and #35.

Soil association #59, a Mollisol, is a good source of topsoil. In a portion of the coal development area covered by soil association #59, steep slopes occur, prohibiting topsoil removal or requiring slope stabilizing techniques such as mulching if the landscape is returned to the original steep topography. Soil erosion would be the direct result of excessive slopes.

The finer clay fraction of soil association #21, an Aridisol, and #62, a Mollisol, could present erosion problems during topsoil removal, storage, and redistribution. Clayey textures are highly susceptible to water and wind erosion. If the amount of exposed bare soil during revegetation and topsoil removal were limited and a quick, protective, vegetative cover were established on stockpiles and replaced topsoil, erosion could be limited. Clayey soils are also easily compacted. Compaction by heavy equipment combined with lack of ability to hold soil moisture would diminish the amount of water available to plants. Overall, soil associations #21 and #62 have a good potential for reclamation, providing all precautions are taken to overcome undesirable effects of clayey textures.

Soil association #35, a Entisol, has a good potential for reclamation, except for its limited capacity to retain moisture during June and July. During this period, retention of moisture by soils is important to survival of vegetation.

Overall the reclamation potential in the study area is good.

Specific characteristics of the soil associations which contribute to these impacts are discribed in Chapter 4, Soils.

Development of coal resources at the low-level would cause the temporary disturbance of 4,690 acres of vegetation by 1980, an additional 5,280 acres by 1985, and an additional 4,830 acres by 1990, totaling 14,800 acres by 1990.

The process of revegetation of the above disturbed acreage would be expected to have begun on 100 acres by 1980, an additional 4,690 acres by 1985, and an additional 5,280 acres by 1990, totaling 10,070 acres by 1990.

Development of coal resources along with ancillary facilities and housing would cause the permanent loss of 1,600 acres of vegetation by 1980, an additional 2,175 acres by 1985, and an additional 785 acres by 1990 for a total permanent loss of 4,560 acres by 1990. These acreages and types of vegetation disturbance can be found in Table 8-4.

Disturbance to vegetation would be expected to involve the following vegetative types: sagebrush, 43 percent (0.55 percent of this type in the total study area (northwest Colorado)); mountain shrub, 25 percent (1.08 percent of this type in the study area); aspen, 9 percent (1.48 percent of this type in the study area); creek bottom, 6 percent (7.6 percent of this type in the study area); cropland, 15 percent (2.4 percent of this type in the study area); pinyon-juniper, 2 percent (0.08 percent of this type the study area).

A direct result from the removal of vegetation would be loss of production for grazing livestock and wildlife. Each vegetative type is calculated as having a certain number of acres per animal unit month (AUM). The sagebrush type has 8 acres per AUM, mountain shrub type 6 acres per AUM, aspen woodlands type 3 acres per AUM, and creek bottom type 1 acre per AUM. For AUMs lost, see Domestic Fauna later in this chapter.

Temporary disturbance of vegetation would result in a loss of vegetative production. Loss of production for livestock and wildlife would mean fewer numbers of each in the areas of coal development - southwest Routt County, southeast Moffat County, and the area northeast of Meeker in Rio Blanco County. This loss of production could be significant to livestock producers whose operations are affected. The significance to an individual operator would be proportional to the area of his operation lost (see Domestic Fauna). The impact of lost production to wildlife would not be significant compared to the total wildlife populations of the study area (see Wildlife).

Total removal of native vegetation from an area would result in additional impacts on the vegetative ecosystem. There would be loss of a diverse vegetation capable of withstanding climatic extremes and utilizing precipitation and sunlight throughout the growing season. There would also be a loss of the present vegetative successional stage. This simpler vegetation would be more susceptible to climatic extremes and diseases. Trans-

planting of trees and shrubs on a site could speed the establishment of a more diverse vegetative ecosystem.

Loss of soil productivity (see Soils) would effect the time needed to reestablish vegetative ecosystems, which could take 20 to 50 years. Current reclamation practices have not been in use long enough to determine whether a significant number of native plant species can be established on reshaped topsoil spoils.

With the loss of vegetation on the site, the probability of increasing livestock and wildlife numbers on adjacent sites is high, with probable over utilization of adjacent sites. Reclamation could reestablish forage after 4 years, however (see Domestic Fauna).

Changes in ground water flows which may result from mining (see Water Resources) would effect vegetation. Increases near the surface would increase vigor and density of vegetation while a loss may have the opposite effect. Where this would occur cannot be predicted but it would be limited to the area of coal development and is not expected to be significant.

Changes in surface water flows would be limited to the area of coal development and not expected to be significant to vegetation.

Threatened and Endangered Species

Vegetation has not been studied in sufficient depth to determine locations of threatened or endangered species within the study area.

Wildlife

Impacts from low-level coal development and ancillary activities would have adverse effects on wildlife habitat and species in the study area. All of the wildlife species in the area would be impacted from the permanent loss of habitat resulting from new roads, power plants, railroads, and construction of housing to accommodate population growth. There would be 1,600 acres of habitat permanently removed by 1980, 3,775 acres by 1985, and 4,560 acres by 1990. In addition to the permanently lost acreage, there would be a temporary disturbance of 4,690 acres by 1980, 9,970 acres by 1985, and 14,800 acres by 1990 from powerline construction and surface mining.

Portions of the area would be revegetated, but by 1990 none of the areas would be considered at carrying capacities comparable to existing wildlife habitat communities (see Chapter 4, Wildlife). Every species of terrestrial fauna in the study area, listed in Appendix D (NWCCRES), would be affected by loss of habitat. The degree of impact would depend on the adaptability of the species involved and their mobility. Because of a lack of species density and composition data for the majority of wildlife species it is impossible to adequately estimate the reduction in carrying capacity for most non-game species that would result from low-level coal development. Those species closely associated with sagebrush and mountain shrub habitat types would be the most severely impacted by coal development while species associated with grasslands would be adversely impacted during mining but beneficially impacted after revegetation (Appendix D, NWCCRES).

Permanently lost habitat would have the most significant impact on game species such as elk, mule deer, antelope, and sage grouse (Table 8-16). Most of the loss would accrue to the sagebrush, mountain shrub, and aspen habitat types, which now constitute deer and elk winter range. This loss would be 3,100 acres, only 0.10 percent of this habitat in the entire study area. Permanent loss of habitat would probably result in the loss of some wildlife (see Table 8-16, footnote 2). This loss would not be significant; it would be small compared to the number of animals lost each year to car-animal collisions between Craig and the Wyoming border. Elk and antelope would be displaced to surrounding areas. There would be a loss of some mule deer, since the population is near carrying capacity on critical habitat sites. Some sage grouse would also be lost, since the loss of habitat would result in destruction of strutting grounds, which are critical for production.

Most species should be absorbed by the surrounding range until the area is revegetated. Winter range for elk, mule deer, and antelope is

TABLE 8-16

ACRES OF WILDLIFE HABITAT PERMANENTLY LOST/TEMPORARILY DISTURBED
AND THE NUMBER OF ANIMALS DISPLACED BY EACH ACTION FROM THE LOW-LEVEL SCENARIO

	1978-80	1978-85	1978-90
Total acres permanently lost	1,600	3,775	4,560
Elk habitat lost	720	1,700	2,050
Elk species displaced 2/	7	10	14
Deer habitat lost	1,600	3,775	4,560
Deer species displaced 2/	30	75	90
Antelope habitat lost	110	260	320
Antelope species displaced 2/	3	5	6
Sage grouse habitat lost	430	1,020	1,230
Sage grouse species displaced 1/	7	17	20
Total acres of habitat disturbed	4,690	9,970	14,800
Elk habitat	2,110	4,500	6,660
Elk displaced 2/	20	42	62
Deer habitat	4,690	9,970	14,800
Deer displaced 2/	90	195	290
Antelope habitat	330	700	1,040
Antelope displaced 2/	3	5	6
Sage grouse habitat	1,300	2,700	4,000
Sage grouse lost	22	45	70

1/ Sage grouse would be lost since the habitat destruction would mean loss of strutting grounds.

2/ Displacement will result in a loss of 30 percent of the displaced animals from temporary disturbance and 50 percent from permanent disturbance.

critical habitat. Their winter range contains sagebrush, mountain shrub, and aspen types. These types make up about 10,100 acres of the 14,800 total acres that would be temporarily disturbed by mining. This 10,100 acres is about 0.3 percent of the total sagebrush, mountain shrub, and aspen types available to these animals in the study area.

Sage grouse losses would probably be permanent because of the loss of strutting grounds, which are critical to their survival.

Legal and illegal hunting pressure would be expected to increase with the influx in the local human population.

Animal harassment would be expected to increase as more people spend their leisure time in the country, either on the roads or in off-road vehicles, mainly snowmobiles. As a result of low-level development, there would be 780 big game road kills in the study area per year by 1990. Despite this increase, and loss of species from habitat disruption and harrassment, losses due to development at low-level would not be significant compared to total wildlife populations.

Many smaller animals would be destroyed during mining, road and railroad construction, and building of homes, schools, power plants, etc. The larger and more mobile species such as deer, elk, coyote, and grouse and other birds would be able to move onto adjacent lands. Approximatley 30 percent of the displaced animals eventually could be lost as the total population would begin to adjust to the carrying capacity of the species' habitat and as animals displaced into unfamiliar territories would become more vulnerable to predation than within their home ranges.

Food and cover shortages as well as spread of disease and parasites would also increase as population densities became greater.

Impacts on wildlife related to the increased noise level, especially around the mine area, could alter feeding and movement patterns for a variety of species.

Degradation of surface water would adversely impact terrestrial wildlife, by degrading the habitat of invertebrates, a major food item of a variety of terrestrial wildlife.

Fences on private lands which would not meet BLM Manual 1737 specifications would account for the loss of some wildlife species. These specifications should mitigate approximately 90 percent of the fence kill loss.

Losses of individuals would not be significant compared to the total population of these wildlife species in the study area. For example, the loss of 90 deer by 1990 averages 8 deer lost per year from 1978 to 1990. This is not significant compared to losses from disease, old age, hunting, poaching, harrassment, and animal-vehicle collisions. Significance of the losses of elk, antelope, and sage grouse is even smaller.

Threatened and Endangered Species

Threatened and endangered species would not be affected by low-level development of federal coal. Six species of endangered wildlife are known or believed to inhabit the study area. Four of the species are on the U.S. Department of the Interior's list of endangered fauna. These are the American peregrine falcon (Falco peregrinus), the black-footed ferret (Mustela nigripes), the whooping crane (Grus americana), and the bald eagle (Haliacetus leucoephalus). The other two, the river otter (Lutra canadensis) and the greater sandhill crane (Grus canadensis tabida) are on the State of Colorado's endangered fauna list.

Domestic Fauna

With the increased vehicle traffic discussed in the Transportation Networks section of Chapter 8, low-level, loss of livestock would increase. The loss of an animal represents an economic loss to the owner. In the study area as a whole, these losses are not expected to be significant. Accidential animal deaths would also be more likely from hunting-related activities. Rustling of livestock and damage to fences and other range improvement facilities would probably result from increases in human population and its use of the region. There are no estimates of these increases available, however, they are not expected to be significant.

Loss of vegetative production would decrease the numbers of livestock that could be grazed in the areas of coal mining. Temporary disturbance of vegetation would result in a loss of vegetative production. A period of approximately 4 years following the time of disturbance would occur before reclamation would have progressed sufficiently to permit grazing. The temporary disturbance to vegetation which would occur by 1980 would result in an eventual loss of 3,480 AUMs, the additional disturbance to vegetation occurring by 1985 would result in a loss of 3,920 AUMs, and the disturbance to vegetation by 1990 would result in 3,580 AUMs lost for a total of 10,980 AUMs lost.

The permanent loss of production resulting from the permanent loss of vegetation would be 300 AUMs per year by 1980, 700 AUMs per year by 1985, and 850 AUMs per year by 1990. These areas are southeast Routt County, southwest Moffat County, and the area northeast of Meeker in Rio Blanco County. This loss of production could be significant to an individual livestock operator, but would not be significant regionally.

Changes in surface water and ground water, discussed under Water Resources, could have an effect on livestock distribution near areas of coal development. The loss of small impoundments of water or water flow from wells supplying livestock could cause a reduction in numbers of livestock that could be supported in a given area. Due to the unpredictable nature of impacts to these water supplies, it is not known if there will be a significant impact to livestock operations. Effects of groundwater on vegetation are not expected to be significant to livestock.

Aquatic Biology

At low-level coal development in the study area minor adverse impacts to aquatic biology would result from population growth and developments ancillary to coal such as housing developments, power plants, and railroads. These developments would result in a permanent loss of aquatic habitat due to disturbance of land - 95 acres by 1980, 225 acres by 1985, and 275 acres by 1990. Destruction of habitat from accompanying increases in stream sedimentation during construction of roads, power plants, railroads, and housing developments would be localized and short-term.

Population growth would result in water treatment facilities being progressively overloaded and therefore water quality being degraded below population centers. This degradation of water quality would be long-term and would occur principally below Hayden, Steamboat Springs, and Oak Creek on the Yampa River and below Meeker on the White River. This impact cannot be quantified because it cannot be predicted exactly what types of facilities would be constructed to treat waste.

Loss of aquatic habitat would also occur due to developments along perennial streams and increases in agriculture-related activities. Construction of housing along streams would permanently claim about 5 acres of aquatic habitat by 1980, 70 acres by 1985, and 80 acres by 1990. As a result of land being disturbed for new housing, there would be more concentrated use of aquatic habitat in adjacent areas. Population growth would also create a direct loss of habitat from increases in agriculture-related activities. As more cropland would be created for farming, domestic animals would damage already limited riparian habitat.

The multiple impacts of population growth on fisheries are not expected to be of any significance, however. Areas that would be principally impacted do not have blue ribbon trout fisheries. Also, increases in sport fishing attributable to new population would not greatly affect these fisheries, but instead would increase the demand for a put-and-take trout fishery near the major population centers.

Threatened and Endangered Species

Threatened and endangered species of aquatic animals found in the study area would not be affected by low-level development of federal coal. The White and Yampa Rivers provide habitat for the Humpback chub (Gila cypha) and the Colorado River squawfish (Ptychocheilus lucius), which are on the U.S. List of Endangered Fauna and the Colorado List of Endangered Species. The White and Yampa Rivers also provide habitat for the humpback sucker (Xyraucher texanus) and the bonytail chub (Gila elegans), the former of which is on the Colorado List of Threatened Species, the latter on the Colorado List of Endangered Species. Portions of these rivers that are habitat for these animals would not be affected by mining and related activities.

Archeological Resources

With low-level production, the possible impacts are of lesser magnitude than at mid-level. Since all required surveys for both production levels have not been completed, numerical differences cannot be expressed. At least one adverse impact would be ameliorated. Less acreage would be involved in community expansion at low-level production.

One site described in Table 2-23 has, following laboratory analysis, been recommended for nomination to the National Register of Historic Places (NRHP). The site is designated 5RT32. At low-level production, 5RT32 would be subjected to surface collection only as long as mining continues near it.

From past surveys, 37 sites are recorded in areas of development. Four of these sites discussed above, 5MF435, 5MF444, 5MF681, and 5RT32, are eligible to NRHP (Table 2-23).

By 1980 at least the 37 sites will be involved. Loss of sites and data on private leases and possible surface collection losses of unidentified sites in pit areas of federal and state leases would be qualitatively similar as those at mid-level. As at mid-level, all sites involved in community expansion would be considered lost.

By 1985 the number of sites involved in mining activities resulting from development of federal coal would remain the same. Loss of sites on private leases and in the pit areas of state and federal leases would continue.

By 1990 the numbers of sites directly impacted by mining activity resulting from development of federal coal would remain constant or perhaps decrease as mines are closed. Losses of sites on private leases and in the pit areas of state and federal leases would continue.

As stated in Chapter 4, what is significant is that mining would be concentrated in areas where sites dating from 5,000 years ago through historic times have been located. Loss of data through casual collection or loss of or damage to sites may bias prehistoric reconstruction within the study area and for the Northwestern Plains area.

Historic Resources

The most damaging direct impact would result from earth disturbance when a specific mining site is developed; such disturbance includes roads, haulways, powerlines, portals, and structures all of which could destroy historic sites by displacement. Such sites could also be harmed by subsidence, but this impact would be minimal since lands subject to subsidence would have been inventoried and those sites located on lands prone to subsidence would have been recorded prior to development. There are presently no known historic sites on land that would be disturbed by low-level development, but examination of the study area is incomplete.

Secondary impacts would occur when development changes the character of a region. For instance, historic sites could be vandalized at increased rates as a result of population increases and the attendant visitor use increases. The development of roads and railroads would degrade the integrity of historic sites located in the region and near development by altering the aesthetic surrounding.

A less obvious secondary impact would result from population increases in established towns such as Hayden, Steamboat Springs, Meeker and Oak Creek. New construction would displace older buildings and sites. However, certain areas both on the city and county level that are classified or zoned historic areas would be protected from rapid undisciplined development.

Aesthetics

Visual Resources

Impacts to the study area's visual resources at low-level depend on the size and the visual sensitivity of specific sites of coal development.

There are several activities of mining that create stark contrasts to the existing landscape. Those associated with surface mining are:

- spoil piles or dump areas
- active pit(s)
- clearings
- associated haul roads, electrical and water rights-of-way, railroads
- associated structures
- lights at night

Those associated with underground mining are:

- flat areas for:
  - operations structures
  - coal storage
  - equipment storage
  - road, rail, and electrical and water rights-of-way

Ratings by BLM's Visual Resource Management system to indicate adverse impacts of development will not be made unless there is additional development of federal coal. However, areas most vulnerable to adverse impacts to visual resources are generally indicated.

Eastern Routt County. Most of this area is visible from U.S. 40, Colorado 131, and the Hahn's Peak Road, and therefore would be visually impacted by mining. Scenic quality in most of the area is high, because of the landscape variety generated by vegetation, topography, and rivers and streams.

Mt. Harris Area. Landscape visibility in this area is less than in eastern Routt County, although areas adjacent to U.S. 40 have great exposure for short distances and would be visually impacted by mining. View of landscapes further north and south is partially obscured by topo-

graphy. Scenic quality is characteristic to outstanding in the rolling to rugged mountain-high relief topography that dominates this area, extending from the Elkhead Mountains to the north to the Dunckley Flattops to the south.

Western Routt County and Eastern Moffat County. Except for the high visual sensitivity of landscape adjacent to U.S. 40, generally visual sensitivity is moderate in this area because access is provided by county roads, which are less traveled. It is impacted by mining.

Williams Fork Mountains. This landscape is highly visible from U.S. 40, and Colorado 13, and the Williams Fork road and would be visually impacted by mining activities. Further south, near the Flattops, there is only moderate to low sensitivity, because of topographical features and limited access.

Axial Basin. Visibility of the Basin's rolling interior is moderate, but all peripheral lands have a high visual exposure and would be visually impacted by mining. The Basin exhibits gently undulating landscapes of sagegrass types and agriculture, exhibiting minimal to characteristic scenic quality. Landscape variety on the Basin's periphery constitutes characteristic to outstanding scenery. Most of the eastern portion of the Basin has a high visual sensitivity, being visible from Colorado 13.

Meeker Area. Landscape visibility is moderate to high for most of the area. Yellowjacket Pass, Ninemile Gap, and the Wilson Creek Oil Field mark the Danforth Hills divide that separates the Yampa and White River drainages. East of Meeker are the White River's pastoral and agricultural lands and near the National Forest boundary are great topographic definition and vegetative variety. These lands exhibit characteristic to outstanding scenery and would be visually impacted by mining.

Recreation

Impacts to recreation for the low-level scenario can be divided into a loss of recreation opportunities (supply) and increases in recreation demand resulting from population increases. Coal mining and its ancillary developments disturb the land, precluding its use for recreation. Increases in population in the region result in increases in recreation demand.

When land is disturbed, access to recreation lands may be blocked. The mined area's natural landscape is disturbed by removal of vegetation and modification of its topography. Interesting rock formations may also be removed by mining. The mined area's natural capability to attract and sustain recreation use is diminished. Dispersed activities such as hiking, cross-country skiing/snowshoeing, backpacking, nature study, photography, horseback riding, collecting, camping and picnicking would all be impacted. Underground mining can create hazards for recreationists from subsidence and cracking at the surface, endangering activities of foot, horseback, or ORV use, especially motorcycles. However, little area is expected to be impacted by surface cracking because there is relatively little underground mining in the study area at the low-level of production.

The principle impact on recreation would come from disturbance of the land surface. Temporary disturbance would affect 4,690 acres by 1980, 5,280 acres by 1985, and 4,830 acres by 1990 for a total of 14,800 acres. Of these areas temporarily disturbed, 10,070 acres would be revegetated by 1990. Permanent disturbance would occur to 1,600 acres by 1980, 2,175 acres by 1985, and 785 acres by 1990 for a total of 4,560 acres permanently removed from recreation use by 1990.

Loss of recreation opportunities at the low-level would occur principally in the Twenty Mile Park Area south of Hayden, Nine Mile Gap northeast of Meeker, the Williams Fork Mountains south of Craig, Hayden Divide south of Hayden and the area south of Mt. Harris.

Loss of land due to mining would result in the loss of wildlife habitat (see Wildlife), displacement of animals, and the loss of hunting and viewing opportunities. The impact on hunting is difficult to predict because hunters are unaware of changes in wildlife numbers from hunting season to hunting season. Hunters may also be reluctant to hunt near a mining operation because of the feeling that animals may have abandoned the area or that they have been harassed and will be more difficult to hunt. Overall, the study area has a large number of hunting opportunities and the impact of mining on hunting is expected to be insignificant. The exception to this is in Routt County. Table RII-26 of the NWCCRES shows a deficit of 77,000 activity days of hunting for 1974 in Routt County.

There would be no loss of fishing opportunities because the region's fisheries would not be impacted (see Aquatic Biology).

A beneficial impact from mining is that it provides a human-interest feature for people to view and enjoy. Mining facilities are also important education opportunities. Other beneficial impacts from mining would be the uncovering of cultural materials, fossils, and rockhounding materials. However, these materials would generally be destroyed during mining or lost again when backfilling occurs (see Archeological Resources and Paleontology).

The population in the region based on the low-level scenario is: 1977 - 25,929; 1980 - 26,700; 1985 - 37,500; and 1990 - 39,100. Predicted increases in recreation demand in the region are 1977-1980: 3 percent; 1980-1985: 40 percent, and 1985-1990: 4 percent. These increases in recreation demand will increase the recreation deficits, noted in Table RII-26 of the NWCCRES. Surplus and deficits of recreation opportunities are expressed in recreation days. For urban recreation, Routt County has deficits of 11,200 activity days for swimming and 2,900 for tennis. Moffat County has a deficit of 14,900 activity days for tennis and 39,000 activity days for golf. Rio Blanco County did not have any deficiencies for urban recreation. Another deficit existed in Routt County - 77,000 activity days of hunting. Generally, most activities have a large surplus of recreation supply within the region (Table RII-26 of the NWCCRES). This surplus of supply should be able to absorb the projected increase in recreation demand with the exception of those noted.

Coal mining development at the low-level of production would not occur directly in any areas having wilderness values. However, population increases resulting from low-level development would increase the demand for wilderness recreation in the region. Currently, the Flat Tops Wilderness Area and Mt. Zirkel Wilderness Area are the only two formally designated areas in the study area. The BLM is presently inventorying its roadless lands for wilderness potential. There are no data from which to make projections of impacts on wilderness; however, impacts would probably be minimal because of what appears to be a surplus of wilderness opportunities in the region. Many of these opportunities exist in areas not formally designated as wilderness.

An estimated 100,000 visitor days of off-road vehicle use occurs in the study area. A visitor day is defined as a 12-hour period. A major portion of this is snowmobile use in Routt and White River National Forests. Population growth from low-level development is anticipated to have permanent but small impacts on this activity because there appears to be a regional surplus of ORV opportunities. On the assumption that increase in recreation demand is engendered by an increase in population, the increase in ORV demand would be 1977-1980: 3 percent from 1977 to 1980, 40 percent from 1981 to 1985, and 4 percent from 1986 to 1990.

The impacts from ORV activity would be disruption of mood-atmosphere qualities, loss of vegetation, loss of soil, and harassment of wildlife.

Recreation opportunities impacted by coal development would be considered permanent losses because, even though the land would be reclaimed, it would never again be able to attract recreation use similar to its earlier natural capability. However, reclaimed areas could provide ORV opport-

unities.

Increases in population would also increase pressure on towns' sewage treatment facilities, which would lead to increased fecal coliform levels in the Yampa and White Rivers. These increases could make the Yampa River ineligible for designation under the Wild and Scenic Rivers Act.

Demography

Table 8-17 presents low-level population projections, assuming no further development of additional federal coal. Following completion of Colorado-Ute Electric Association's Craig Power Plant and subsequent layoff of most of the present 1,420-man construction workforce, there would probably be a large out-migration of construction workers unable to find alternative local employment (e.g., in coal mine construction). Without further expenditures for power plant construction and related expenditures by construction worker households there would be additional contraction of the local economy, giving rise to additional unemployment and out-migration.

The implications of this would be most pronounced in Craig and in Moffat County, site of the Craig Power Plant and residence of most of the construction workers. Craig, which grew from a population of 4,205 in 1970 to 6,677 in 1977 largely under the impetus of power plant construction is projected to shrink back to 4,100 by 1980 in the absence of further coal development to absorb laid-off construction workers. Since most of these workers are currently transients who came to Craig to work in the power plant project, it is likely they would move out if other jobs were not available. Due to its role as a regional agriculture and trade center, Craig would be expected to gradually regain population, but by 1990 would still have only 6,200 inhabitants, 7 percent less than its 1977 population.

Moffat County's population would also decline, dropping precipitously from 10,313 in 1977 to 7,800 by 1980, then slowly growing to 9,900 by 1990. The County's only other incorporated municipality, Dinosaur, is expected to grow from 347 in 1977 to 500 by 1985 as a result of construction of the U-a/U-b oil shale operation in neighboring Utah, then decline to 460 as U-a/U-b's large construction workforce is replaced by a smaller permanent staff.

Rio Blanco County is expected to grow from 5,100 to 13,900 inhabitants by 1985 at low-level development, fueled by moderate growth in the county's oil and gas production and especially construction of three large oil shale projects on the C-a, C-b, and Superior oil shale tracts. Both Meeker and Rangely would share in the county's rapid population growth through 1985, expanding from 1,848 to 8,400 and 1,871 to 4,100, respectively, in just 7 years. However, after 1985, Meeker and Rangely would face short-term population declines of 800 and 300 inhabitants, respectively, following completion of the three oil-shale plants.

Unlike Moffat and Rio Blanco Counties, Routt County is expected to expand continuously between 1977 and 1990, from 10,516 to 16,200 inhabitants under the combined impetus of coal mining, tourism, and recreation industries. Among individual municipalities, Oak Creek faces a short-term population decline by 1980 as a result of completion of the Craig Power Plant. However, over the long term, Hayden and Oak Creek should

TABLE 8-17

LOW-LEVEL POPULATION PROJECTIONS
1977-1990

County City	1977	1980	Average annual rate of change 1977-1980 1/(%)	1985	Average annual rate of change 1980-1985 1/(%)	1990	Average annual rate of change 1985-1990 1/(%)	Average annual rate of change 1977-1990 1/(%)
Moffat	10,313	7,800	- 9	9,600	4	9,900	1	2/
Craig	6,677	4,100	- 15	5,900	7	6,200	1	- 1
Dinosaur	347	375	2	500	6	460	- 2	2
Rio Blanco	5,100	7,900	16	13,900	12	12,900	- 2	7
Meeker	1,848	4,500	34	8,400	13	7,600	- 2	12
Rangely	1,871	2,000	2	4,100	16	3,800	- 2	6
Routt	10,516	11,000	2	14,000	5	16,200	3	3
Hayden	1,362	1,600	6	2,300	7	3,000	5	6
Oak Creek	756	500	- 13	900	13	1,200	6	4
Steamboat Spgs	4,028	4,500	4	6,300	7	7,600	4	5
Yampa	307	320	1	365	3	360	2/	1
Total	25,929	26,700	1	37,500	7	39,000	1	3

1/ Compounded annually.
2/ Less than 1 percent.

grow in population from 1,362 to 3,000 and 756 to 1,200, respectively, due to the influx of coal mine workers and workers from Steamboat Springs. Steamboat Springs itself, with its expanding year-round recreation industry, would be expected to grow from 4,028 to 7,600 permanent residents. Yampa would also expand somewhat, from 307 to 360 residents.

The regional population at low-level is forecast to increase over 50 percent, from 25,929 to 39,000 by 1990. Trends foreseen under low-level development would alter the present population distribution. That part of the population living in "urban" areas (incorporated places over 2,500 inhabitants plus adjacent settled areas) would grow from 10,705 or 41 percent of the population in 1977 to 28,200 or 72 percent of the population. By 1990, Meeker, Rangely, and Hayden would join Craig and Steamboat Springs as "urban" areas under the census definition.

Economics

Employment. Tables 8-18, 8-19, and 8-20 project low-level trends in sector employment by county in the three-county area. Following completion of the Craig Power Plant early in 1979 and subsequent disbanding of its 1,420-man construction workforce, Moffat County construction employment is projected to drop to approximately one-fourth of its peak 1977 levels, precipitating additional contractions in the local manufacturing trade, and services sectors. The projected increase in local mining employment (from 533 to 790 workers) would be insufficient to absorb all this excess labor, leading to an increase in local unemployment and out-migration of transient construction workers.

A sudden surge in Rio Blanco County construction employment (rising from 204 in 1977 to 3,290 in 1980) would occur as construction of the C-b and Superior oil shale facilities would be begun. Construction of the C-a oil shale installation would begin later. Increase in construction employment as well as growth in oil and gas-related employment (which currently makes up the bulk of mining employment in Rio Blanco County) would also lead indirectly to considerable expansion of Rio Blanco's trade and services sectors. Spot labor shortages would probably occur temporarily as a result of competition between oil shale and other local employers, but would end with the arrival of new workers. Continuing expansion of Routt County's coal mining and tourism- and recreation-related trade and services sectors should cause total county employment to grow from 5,028 in 1977 to 5,540 in 1980. Routt County would not be expected to experience any significant short-term labor shortages because of the large number of unemployed in the area.

These same growth factors (coal, oil and gas, oil shale, and tourism, but particularly coal and oil shale) would continue to exert a dominant influence on the regional economy through 1990. Even in the absence of additional development of federal coal, coal mining employment in Moffat County should grow from 790 to 900 between 1980 and 1990, while in Routt County it would be expected to expand from 760 to 1,200. After its early

TABLE 8-18

LOW-LEVEL PROJECTED EMPLOYMENT BY SECTOR
1980

Sector	Moffat		Rio Blanco		Routt	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
Agriculture	190	4	130	2	170	3
Manufacturing	140	3	60	1	140	3
Coal mining	790	16	20	0.3	760	14
Oil and gas extraction	0	0	730	12	0	0
Shale oil extraction	0	0	0	0	0	0
Construction	490	10	3,290	55	550	10
Transportation, communications, utilities	500	10	290	5	370	7
Trade	460	10	340	6	990	18
Finance, insurance, real estate	180	4	80	1	420	8
Services	540	11	300	5	1,100	20
State and local government	1,460	30	750	13	940	17
Federal government	90	2	50	1	100	2
Total 1/	4,840	100	6,040	100	5,540	100

1/ Total may not add to 100 percent due to rounding.

TABLE 8-19

LOW-LEVEL PROJECTED EMPLOYMENT BY SECTOR
1985

Sector	Moffat		Rio Blanco		Routt	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
Agriculture	200	3	140	1	170	2
Manufacturing	210	4	90	1	220	3
Coal mining	980	17	20	0.2	1,170	16
Oil and gas extraction	0	0	1,040	10	0	0
Shale oil extraction	0	0	1,600	15	0	0
Construction	490	8	4,000	38	510	7
Transportation, communications, utilities	640	11	370	4	480	7
Trade	590	10	780	8	1,200	17
Finance, insurance, real estate	250	4	120	1	600	8
Services	650	11	670	6	1,290	18
State and local government	1,700	29	1,540	15	1,330	19
Federal government	100	2	60	1	130	2
Total 1/	5,810	100	10,430	100	7,100	100

1/ Total may not add to 100 percent due to rounding.

TABLE 8-20

LOW-LEVEL PROJECTED EMPLOYMENT BY SECTOR
1990

Sector	Moffat		Rio Blanco		Routt	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
Agriculture	200	3	140	1	180	2
Manufacturing	240	4	100	1	260	3
Coal mining	900	15	20	0.2	1,200	15
Oil and gas extraction	0	0	1,560	16	0	0
Shale oil extraction	0	0	4,560	45	0	0
Construction	560	9	220	2	560	7
Transportation, communications, utilities	710	12	410	4	530	6
Trade	620	10	720	7	1,380	17
Finance, insurance, real estate	290	5	130	1	680	8
Services	700	11	610	6	1,610	20
State and local government	1,750	29	1,540	15	1,650	20
Federal government	150	3	80	1	180	2
Total 1/	6,120	100	10,090	100	8,230	100

1/ Total may not add to 100 percent due to rounding.

decline between 1977 and 1980, total employment in Moffat County is projected to grow from 4,840 in 1980 to 6,120 by 1990, which is still about 6 percent below 1977 levels. Total employment in Routt County would continue to grow from 5,540 in 1980 to 8,230 in 1990, a 64 percent increase since 1977.

Rio Blanco County's oil production is expected to level off after 1980, but the county's shale oil industry is expected to add over 4,500 permanent employees between 1980 and 1990. The completion of shale oil construction after 1985 would lead to an overall decline in the county's workforce, which is partly reflected in the drop in Rio Blanco's population between 1985 and 1990. Nevertheless, total employment in Rio Blanco County by 1990 is projected at 10,090, 337 percent above 1977 employment levels.

Despite these trends, employment structures of the Moffat and Routt County economies would not be significantly altered under low-level development. Rio Blanco's spectacular growth in employment would be at the expense of a much greater long-term dependence on hydrocarbons--pertroleum, natural gas and especially oil shale--for the county's economic livelihood. In view of this dependence, the consequences of any severe market dislocations in these industries (for example, a decline in the price of crude petroleum which made synthetic lke shale oil less economically attractive) could have severe repercussions on the Rio Blanco County economy.

Income. Under the low-level development, total wage and salary earnings in Moffat County are projected to decline precipitously between 1977 and 1980, from $73.2 million to $49.9 million, as a result of completion of the Craig Power Plant and subsequent construction worker layoffs. (All figures cited are expressed in 1976 dollars.) Local construction worker earnings should decline from $32.8 million in 1977 to $8.2 million in 1980, or from 44.9 percent of total wage and salary earnings to 16.5 percent. Completion of the power plant project would also lead indirectly to a contraction in trade and services earnings (from $6.7 to $3.7 million and $5.5 to $4.2 million, respectively)(Tables 8-21,8-22, 8-23).

In the absence of additional development of federal coal, Moffat County wage and salary earnings would be expected to increase from their 1980 low, but projected 1990 earnings of $62.9 million are 14 percent below their 1977 levels. Average worker earnings in Moffat County would simultaneously decline 6 percent, from $11,044 in 1977 to $10,405 by 1990.

Development of Rio Blanco County's oil shale resources would have a revolutionary impact on the wage structure of the local economy. Total county wage and salary earnings would more than quintuple between 1978 and 1985, from $23.8 million to $133.3 million, before declining to $115.6 million in 1990 as the large oil shale construction force is replaced by a smaller operating workforce. The temporary influence of high construction wages is also reflected in the average annual wage for Rio Blanco County residents, which should rise from $10,508 in 1977 to $12,031 by 1985 before declining to $10,992 in 1990. By 1990, Rio Blanco County would depend on the mining sector (oil, gas, and oil shale production)

TABLE 8-21

LOW-LEVEL SCENARIO: PROJECTED WAGE AND SALARY EARNINGS
1980

Sector	Moffat		Rio Blanco		Routt	
	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total
Agriculture	1,030	2.1	706	0.9	906	1.6
Manufacturing	1,502	3.0	625	0.8	1,546	2.8
Coal mining	12,239	24.5	232	0.3	11,774	21.0
Oil and gas extraction	0	0.0	9,671	11.8	0	0.0
Shale oil extraction	0	0.0	0	0.0	0	0.0
Construction	8,248	16.5	55,787	67.8	9,267	16.6
Transportation, communication, utilities	6,244	12.5	3,621	4.4	4,645	8.3
Trade	3,705	7.4	2,764	3.4	7,923	14.2
Finance, insurance real estate	1,378	2.8	634	0.8	3,280	5.9
Services	4,152	8.3	2,319	2.8	8,589	15.4
State and local government	10,029	20.1	5,156	6.3	6,434	11.5
Federal government	1,353	2.7	732	0.9	1,576	2.8
Total 1/	49,880	100.0	82,247	100.0	55,940	100.0
Average wage and salary earnings per worker (resident adjusted)	10,463		12,380		9,941	

1/ Totals may not add to 100.0 percent due to rounding.

TABLE 8-22

LOW-LEVEL SCENARIO: PROJECTED WAGE AND SALARY EARNINGS
1985

Sector	Moffat		Rio Blanco		Routt	
	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total
Agriculture	1,068	1.8	728	0.5	938	1.3
Manufacturing	2,280	3.8	954	0.7	2,456	3.4
Coal mining	15,182	25.3	232	0.2	18,126	25.3
Oil and gas extraction	0	0.0	13,855	10.4	0	0.0
Shale oil extraction	0	0.0	21,255	15.9	0	0.0
Construction	8,231	13.7	67,735	5.8	8,571	12.0
Transportation, communication, utilities	8,071	13.4	4,658	3.5	5,969	8.3
Trade	4,753	7.9	6,257	4.7	9,577	13.4
Finance, insurance real estate	1,957	3.3	900	0.7	4,665	6.5
Services	5,002	8.3	5,141	3.9	9,950	13.9
State and local government	11,693	19.5	10,613	8.0	9,129	12.8
Federal government	1,815	3.0	987	0.7	2,133	3.0
Total 1/	59,998	100.0	133,315	100.0	71,514	100.0
Average wage and salary earnings per worker (resident adjusted)	10,438		12,031		9,931	

1/ Totals may not add to 100.0 percent due to rounding.

TABLE 8-23

LOW-LEVEL SCENARIO: PROJECTED WAGE AND SALARY EARNINGS
1990

Sector	Moffat		Rio Blanco		Routt	
	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total
Agriculture	1,084	1.7	733	0.6	954	1.2
Manufacturing	2,620	4.2	1,096	0.9	2,796	3.4
Coal mining	13,788	21.9	232	0.2	18,668	22.9
Oil and gas extraction	0	0.0	20,750	17.9	0	0.0
Shale oil extraction	0	0.0	60,535	52.4	0	0.0
Construction	9,572	15.2	3,649	3.2	9,572	11.7
Transportation, communication, utilities	8,878	14.1	5,170	4.5	6,606	8.1
Trade	4,932	7.8	5,747	5.0	11,014	13.5
Finance, insurance real estate	2,230	3.5	1,025	0.9	5,323	6.5
Services	5,342	8.5	4,731	4.1	12,454	15.2
State and local government	11,995	19.1	10,613	9.2	11,342	13.9
Federal government	2,452	3.9	1,338	1.2	2,866	3.5
Total 1/	62,893	100.0	115,619	100.0	81,595	100.0
Average wage and salary earnings per worker (resident adjusted)	10,405		10,992		9,811	

1/ Totals may not add to 100.0 percent due to rounding.

for $81 million, or over 70 percent of total county wage and salary earnings. Such a high degree of economic dependence on mineral resources may be undesirable in view of the potential impact of market disruptions (for instance, if a sudden drop in oil prices made shale oil processing uneconomical) on the local economy. If Rio Blanco County is unable to diversify its economy, it also faces the probability of a "bust" in the next century when oil shale operations are completed. While Routt County, like Moffat, would experience substantial growth in mining earnings under low-level development (from $7.4 million in 1977 to $18.7 million in 1990, an increase of 154 percent), this growth would not lead to as exaggerated a dependence on local mining earnings (Table 4-24). By 1990, mining earnings would account for 23 percent of total wage and salary earnings in Routt County.

Although Routt County may be considered less economically vulnerable than Moffat or Rio Blanco due to its lower dependence on mining and/or construction earnings, an important trade-off is seen in Routt County's lower average wage and salary level. While the average annual rate of compensation among Routt County residents is expected to increase by nearly 8 percent between 1977 and 1990, from $9,087 to $9,811, it would remain substantially below the average for either Moffat or Rio Blanco Counties. This disparity results form the higher concentration in Routt County of workers in lower-paying (albeit more stable) occupations such as trade and services.

Under low-level development, inflationary pressures on the Moffat County economy should ease somewhat due to the decline in total and per worker earnings as well as significant overcapacity in the local housing market. By contrast, Routt and in particular Rio Blanco Counties should experience considerable price inflation due to higher incomes as well as shortages of such key items as housing. Inflation would erode the real incomes of all residents, although the impacts would be more severe for persons with low or fixed incomes than relatively highly-paid mining and construction workers.

Growing disparties in the cost of living among the different counties could lead to a shift in population distribution between Moffat and the other counties (especially Rio Blanco) as people locate in Moffat County to avoid the high cost of living elsewhere.

Investment Patterns

Table 8-24 contains projections of major trends in private investment (in 1976 dollars) by county for selected sectors (coal, power plants, oil shale, water reclamation and recreation under low-level development between 1978 and 1990).

Projected overall investment at low-level is highest in the 1978-1980 period (over $1.1 billion), declining to approximately $516 million between 1985 and 1990. Coal mining is relatively unimportant compared with overall investment, with a maximum of $33.1 million or 2.9 percent of

TABLE 8-24

LOW-LEVEL EXPECTED MAJOR PRIVATE
INVESTMENTS BY COUNTY, 1978-1990
(Millions of 1976 Dollars)

Sector/county	1978-1980	1981-1985	1986-1990
Coal mines			
Moffat	24.9	0	0
Routt	8.2	5.8	0
Power plants			
Moffat	90.0	0	0
Oil shale			
Rio Blanco	1,000.0	800.0	450.0
Water reclamation			
Moffat	0	50.0	0
Ski area expansion	8.3	28.2	46.2
Total all sectors			
Moffat	114.9	50.0	0
Rio Blanco	1,000.0	800.0	450.0
Routt	16.5	34.0	46.2
3-county region	1,131.4	884.0	496.2

the total between 1978 and 1990, declining sharply thereafter. Coal investment is most important in Moffat County, where it should account for $24.9 million or 22 percent of the total between 1978 and 1990. In Routt County, additional investment in coal should be approximately $8.2 million or 50 percent of total investment between 1978 and 1980, $5.5 million or 17 percent of total 1980-1985 investment, and zero thereafter.

The Craig Power Plant would be the single greatest investment in Moffat County. The $90 million shown between 1978 and 1990 represents only the final installments of a total investment in excess of $700 million.

Expected multi-billion dollar investments in oil shale operations would dwarf all other components of local investment. Total investments in oil shale from 1978 to 1990 are projected at $2.25 billion or almost 90 percent of all investments in the three-county area. All oil shale investment would take place in Rio Blanco County, greatly strengthening the latter's public revenue base as well as its entire economy.

The investments discussed above would have their principal impact on the finances of counties and school districts in which they are located. Nearby municipalities probably would not experience any direct impact on their property tax base, but would gain through increased property tax assessments on worker housing as well as associated commercial development. The chief exception is expansion of the Steamboat Springs Ski area, much of which would take place within the corporate limits of Steamboat Springs.

Retail Trade. Table 8-25 contains projections of retail sales by county and municipality at low-level expressed in 1976 dollars. Moffat is the only county expected to experience a decline in retail sales between 1977 and 1980. Due to completion of the Craig Power Plant and departure of most of the 1,420-man construction force, most of the decline would be concentrated in Craig, in which projected 1980 retail sales are $50.4 million, or 23 percent lower than in 1975. This decline would have a significant direct adverse impact on retail trade employment and earnings. It would also have an indirect, negative impact on local government finances in Moffat County and Craig due to reduction in sales tax revenues.

Rio Blanco and Routt Counties and their municipalities would experience significant increases in retail sales. In Rio Blanco County, projected retail sales would peak at $171 million in 1985 (over 450 percent higher than 1977 levels), before declining to $157 million in 1990 as a result of completion of oil shale construction. Meeker and Rangely show a similar pattern, with sales increasing from $9.5 million to $52 million and $18.2 million to 100.5 million, respectively, between 1977 and 1985, then declining.

Routt County is the only county to show a steady increase in projected retail sales between 1977 and 1990. County sales are expected to increase by over 75 percent, from $65.2 million to $114.5 million, from 1978-1990. Most of this increase would be concentrated in Steamboat Springs, whose retail sales should rise from $43.8 million to $76.8 million, a 75 percent increase between 1977 and 1990.

TABLE 8-25

LOW-LEVEL PROJECTED RETAIL SALES
1980-1990

County/ Municipality	Projected annual retail sales (thousands of dollars) 1980	1985	1990
Moffat	60,975	78,647	85,882
Craig	50,426	65,041	71,024
Dinosaur	610	786	859
Rio Blanco	103,188	170,972	157,450
Meeker	31,575	52,317	48,180
Rangely	60,675	100,531	92,581
Routt	70,355	92,324	114,510
Hayden	3,870	5,078	6,298
Oak Creek	1,829	2,400	2,977
Steamboat Springs	47,208	61,949	76,836
Yampa	774	1,056	1,260
Total	234,518	341,943	357,842

Local Services

The impact of low-level population on local services would vary widely among individual communities. Public services and facilities in a number of communities in the three-county area, at least in the short-term, would be overloaded. In most cases, these services should begin to catch up with the population in the middle term. In the long term, more and better services should be available to all.

Police service requirements likely at low-level are shown in Table 8-26. Craig would have a surplus of manpower and vehicles in its police force by 1980 because of the departure of construction and other related workers following the completion of the Craig Power Plant. Police service requirements in Craig would remain lower than the current number of officers and patrol cars through 1990. Dinosaur would have to establish its own police force or the Sheriff's office would have to extend its coverage to include the town in order to meet the projected requirements at low-level.

Table 8-27 shows fire service requirements at low-level. Half of the towns would need no additional pumping capacity to adequately service the projected population through 1990, half would need additional pumping capacity.

Excess capacity in water supply would be expected in all communities through 1990 except Steamboat Springs (in the winter) (Tables 8-28 and 8-29). The current sewage treatement facility in Meeker is meeting current demand but by 1980 would be deficient. If the current facilities were expanded to meet projected 1985 demand, there would be an excess of 9 percent in sewage treatment capacity by 1990, because of the expected population decline in Meeker between 1985 and 1990. Craig has received a federal grant to expand current sewage treatment capacity to 3.4 MGD by 1980, which would be sufficient to meet demand through 1990.

Housing

Population change in northwest Colorado projected for low-level development would affect housing demand, which is determined by housing preferences and ability of residents to pay for their preferred type of housing (Table 8-30).

The only demand for additional housing in Moffat County would be for single family dwellings, which would increase in spite of an expected lower population because of shifts in housing preferences.

In Rio Blanco County, about 78 percent of the demand for additional housing would be for mobile homes by 1980. Availability of mobile homes would have to increase about 33 percent to meet this demand, about five times the increase in mobile homes in the county between 1970 and 1977. By 1990, 97 percent of additional low-level housing demand would be for single family houses. Availability of single family units would have to increase 7.4 percent to meet this demand, about 4.5 times the annual increase

TABLE 8-26

LOW-LEVEL POLICE SERVICE REQUIREMENTS

Town	Current service		1980 4/		1985 4/		1990 4/	
	Officers	Patrol cars	Officers	Patrol cars	Officers	Patrol cars	Officers	Patrol cars
Craig	17 (h) 2/	6 (a) 3/	8	3	12	4	12	4
Dinosaur 1/	0	0	1	1	1	1	1	1
Meeker	4 (a)	2 (h)	10	3	17	6	15	5
Rangely	4 (a)	4 (h)	4	1	8	3	8	3
Hayden	3 (a)	2 (h)	3	1	5	2	6	2
Oak Creek	1 (i)	1 (h)	1	1	2	1	3	1
Steamboat Springs	14 (a)	9 (h)	20	7	27	9	36	12
Yampa	1 (a)	1 (h)	1	1	1	1	1	1

1/ County deputy lives in the town.
2/ Assessment of current service levels based on accepted national police planning standards: (a) for towns over 10,000, 1.7 officers per 1,000 population is adequate; for towns under 10,000, 2 officers per 1,000 population is adequate; (h) indicates above average level; and (i) is below adequate level.
3/ The accepted national standard for adequate (a) patrol vehicles is 1 car per 3 officers, (h) would be less than 3 officers per car.
4/ Future service needs based on adequate service standards.

TABLE 8-27

LOW-LEVEL FIRE SERVICE REQUIREMENTS

Town	Area served	Current pumping capacity 1/	1980 Required pumping capacity	1985 Required pumping capacity	1990 Required pumping capacity
Craig	Metropolitan area	2,800	1,750	2,500	2,500
Dinosaur	City limits	750	500	500	500
Meeker	City limits	1,225	2,250	3,000	3,000
Rangely	City limits	1,000	1,500	2,000	2,000
Hayden	Town plus radius of 10 miles county	3,250	1,250	1,500	1,750
Oak Creek	Metropolitan area	1,250	500	1,000	1,250
Steamboat Springs	Metropolitan area	1,250	3,500	4,000	4,500
Yampa	City limits	250	500	500	500

1/ Pumping capacity shows the combined GPM (gallons pumped per minute) of a fire department's fire fighting vehicles.

TABLE 8-28

LOW-LEVEL WATER SUPPLY REQUIREMENTS

Town	Current maximum capacity (MGD) 1/	1980 Maximum 2/ demand (MGD)	1980 Excess capacity (%)	1980 Over capacity (%)	1985 Maximum 2/ demand (MGD)	1985 Excess capacity (%)	1985 Over capacity (%)	1990 Maximum 2/ demand (MGD)	1990 Excess capacity (%)	1990 Over capacity (%)
Craig	5.0	1.2	76		1.8	64		1.9	62	
Dinosaur	.274	.112	58		.150	43		.135	51	
Meeker	2.9	1.3	55		2.5	14		2.3	20	
Rangely	2.16	.603	72		1.2	44		1.1	49	
Hayden	1.3 3/	.486	63		.696	46		.80	31	
Oak Creek	1.4	.151	89		.280	80		.335	76	
Steamboat Springs (winter)	5.0	3.5	30		4.8	4		6.3		26
Yampa	1.2	.095	92		.110	90		.108	91	

1/ MGD = million gallons per day.
2/ Colorado state planning office standard for maximum (peak) daily demand = 300 gallons per day per capita.
3/ Hayden water supply currently not able to meet demand. New plant to be functioning summer 1978 with the maximum capacity of 1.3 MGD.

TABLE 8-29

LOW-LEVEL SEWAGE TREATMENT REQUIREMENTS

Town	Current treatment capacity (MGD) 1/	1980			1985			1990		
		Treatment demand 2/ (MGD)	Excess capacity (%)	Over capacity (%)	Treatment demand 2/ (MGD)	Excess capacity (%)	Over capacity (%)	Treatment demand 2/ (MGD)	Excess capacity (%)	Over capacity (%)
Craig	2.5	.695	72		.936	60		1.1	56	
Dinosaur	.17	.063	64		.084	52		.077	58	
Meeker	.4	.753		88	1.3		250	1.3		225
Rangely	1.7	.338	80		.695	59		.640	62	
Hayden	.73	.272	64		.390	48		.498	34	
Oak Creek	.35	.085	77		.157	57		.209	42	
Steamboat Springs (winter)	2.4	2.0	16		2.7		12	3.5		46
Yampa	.084	.053	37		.061	27		.061	27	

1/ MGD = million gallons per day.
2/ Based on national and Colorado state planning standard of 168 gallons per day per capita.

TABLE 8-30

LOW-LEVEL ADDITIONAL HOUSING DEMAND

County	1977 housing units 1/	Additional housing demanded by type of unit 2/ 1980 Number	1980 Percent of total(%)	1980 Average annual growth rate 1977-1980(%)	1985 Number	1985 Percent of total(%)	1985 Average annual growth rate 1977-1985(%)	1990 Number	1990 Percent of total(%)	1990 Average annual growth rate 1977-1990(%)
Moffat										
Single family	2,069	78	100.0	1.2	623	100.0	3.3	893	100.0	6.9
Multiple family	584	0	0	0	0	0	0	0	0	0
Mobile homes & other	1,125	0	0	0	0	0	0	0	0	0
Total units	3,778	78	100.0	0.7	623	100.0	1.9	893	100.0	1.6
Rio Blanco										
Single family	1,621	127	22.0	2.5	1,538	58.6	8.7	2,482	97.2	7.4
Multiple family	225	0	0	0	213	8.1	8.7	71	2.8	2.1
Mobile homes & other	340	451	78.0	32.5	872	33.2	17.2	0	0	0
Total units	2,186	578	100.0	8.1	2,623	100.0	10.4	2,553	100.0	6.1
Routt										
Single family	2,851	420	100.0	4.7	1,016	88.2	3.9	1,776	89.4	3.8
Multiple family	2,132	0	0	0	0	0	0	0	0	0
Mobile homes & other	715	0	0	0	136	11.8	2.2	211	10.6	2.0
Total units	5,698	420	100.0	2.4	1,152	100.0	2.3	1,987	100.0	2.3

1/ Estimates based upon State of Colorado, Division of Housing, Housing in Colorado: Estimates of Housing Inventory and Household Characteristics for January 1, 1977 and Projections of Household Growth to January 1, 1982. March, 1978.

2/ Housing "demand" is the response to a question "What type of housing would you be willing and able to move into if it were available?"

Source: Based on Construction Worker Profile, Summary Report, December, 1975.

Note: Percentages may not total 100.0 due to rounding.

in single family units in Rio Blanco County between 1970 and 1977.

All of the additional demand for housing in Routt County by 1980 and over 85 percent by 1985 and 1990 would be for single family dwellings. To meet this demand, availability of single family dwellings would have to increase 3.8 percent, about 19 percent over the annual increase in single family dwellings in Routt County between 1970 and 1977.

There would be more units in the current housing stock in Moffat County through 1990 and in Routt County through 1985 than would be needed to accommodate population at low-level. In Moffat County, the excess of units would be due to the expected population decline. The excess in Routt County would be due to the number of second homes in the housing stock that are not generally available for year-round rent. Not until after 1985 would population increases make an expansion of the housing supply necessary, but shifts in population and preferences for types of housing would create demand for additional single family units in Moffat and Routt Counties and some additional mobile homes in Routt County. Rio Blanco would have to expand its housing stock by 1980, 1985, and 1990 in order to accommodate increases in population as well as to meet changes in preferences for types of housing.

Some residents of the region would be unable to live in their preferred type of housing at a cost they could afford unless the availability of housing increases, forcing prices down. Generally, availability of different types of housing would have to increase at a higher rate than from 1970 to 1977, except in Routt Coutny where the current rate of increase in the availability of mobile homes would exceed projected demand.

Education

Table 8-31 projects school district enrollments for the three-county region at low-level. The following is a summary of what these school enrollment projections would mean to each school district.

Moffat-Craig. No expansion of facilities would be needed.

Rio Blanco-Meeker. Increased space for 97 students would be necessary by 1980 and for an additional 1,190 by 1985, when enrollments are projected to peak. To meet these increases two elementary schools with capacities of 400 each and one new junior high school with a minimum capacity of 500 should be built. Construction of these facilities would have to be completed between 1980 and 1984. In the short term, projected increases in enrollment through 1980 could be absorbed through use of existing church buildings and Sunday school facilities (Holmes, personal communication, 1978).

In order to maintain current pupil/teacher ratios, 44 new teachers would have to be hired by 1980 and 64 additional teachers between 1980 and 1985. Between 1985 and 1990, 13 of these positions would no longer be necessary, due to enrollment decreases.

TABLE 8-31

LOW-LEVEL SCHOOL DISTRICT POPULATION AND ENROLLMENT PROJECTIONS

County School district	1977				1980				1985				1990			
	Population	Elementary	Secondary	Total	Population	Elementary	Secondary	Total	Population	Elementary	Secondary	Total	Population	Elementary	Secondary	Total
Moffat																
Craig - RE #1	10,313	1,323	1,141	2,464	7,799	918	781	1,699	9,640	1,214	1,044	2,258	9,947	1,263	1,088	2,351
Rio Blanco																
Meeker - RE #1	1,848	385	342	727	4,480	809	718	1,527	8,396	1,439	1,278	2,717	7,642	1,318	1,278	2,596
Rangley - RE #4	1,871	283	334	617	2,010	305	354	659	6,431	648	658	1,306	6,104	595	611	1,206
Routt																
Hayden - RE #1	1,362	280	228	508	1,621	322	265	587	2,321	435	365	800	2,966	539	457	996
Steamboat Springs - RE #2	4,028	737	681	1,418	4,485	811	746	1,557	6,294	1,102	1,005	2,107	7,574	1,308	1,188	2,496
South Routt - RE #3	1,063	286	197	483	820	247	162	409	1,297	324	230	554	1,605	374	274	648

Rio Blanco-Rangely. The projected school district capacity would suffice until the 1984-85 school year, when enrollment would exceed capacity by about 100 pupils. Because of the projected decrease in enrollment between 1985 and 1990, modular classrooms would be suitable to meet short-term capacity problems.

In order to maintain current pupil/teacher ratios, 2 new teachers would have to be hired between 1977 and 1980 and 46 additional teachers between 1980 and 1985. Between 1985 and 1990, 7 of these positions would no longer be necessary, due to enrollment decreases.

Routt-Hayden. The current school district capacity would be adequate until about 1981-82. The projected school district capacity would be adequate through 1990.

In order to maintain current pupil/teacher ratios, 6 new teachers would have to be hired by 1980, 14 additional teachers between 1980 and 1985, and 15 additional teachers between 1985 and 1990.

Routt-Steamboat Springs. The current and projected school district capacity would be exceeded by about 1981-82. Potential capacity of the existing buidlings, with additions, would suffice until the latter part of 1985-1990, when a new elementary school would be required.

To maintain current pupil/teacher ratios, 8 new teachers would have to be hired by 1980, 30 additional teachers between 1980 and 1985, and 21 additional teachers between 1985 and 1990.

Routt-South Routt. The current facilities with projected capacity would be sufficient for projected school enrollment. To maintain current pupil/teacher ratios, 5 teaching positions could be eliminated between 1977 and 1980, 9 new teachers hired between 1980 and 1985, and 7 additional teachers hired between 1985 and 1990.

Health Care Services

Since many residents cross county lines to obtain hospital services, need for hospital beds is projected for the three-county region rather than on a county by county basis. Taking into consideration existing hospital facilities and current expansion of one of the hospitals, no additional hospital beds would be needed in northwest Colorado through 1990.

The recommended number of physicians and registered nurses called for at low-level is shown in Table 8-32. Only Routt County would have a sufficient number of physicians through 1990. By 1985, additional physicians would be needed in Moffat and Rio Blanco Counties, but by 1990 one fewer physician would be needed in Rio Blanco County than in 1985 because of the expected population decline. A shortage of registered nurses would be experienced through 1990 in each of the three counties.

TABLE 8-32

LOW-LEVEL NEED FOR HEALTH CARE SPECIALISTS

County	Current number 1/	1980 Total need	1980 Additional need	1985 Total need	1985 Additional need	1990 Total need	1990 Additional need
Moffat							
Physicians	4	4	0	5	1	5	1
Registered nurses	26	27	1	34	8	35	9
Rio Blanco							
Physicians	4	4	0	7	3	6	2
Registered nurses	26	28	2	49	23	45	19
Routt							
Physicians	8	5	0	7	0	8	0
Registered nurses	34	39	5	49	15	57	23

1/ 1976 for physicians.
1972 for registered nurses.

Source: Based on a population to physician ratio of 1:2,000 and a population to registered nurses ratio of 1:285.

Again, because of the expected population decline in Rio Blanco County between 1985 and 1990, fewer additonal registered nurses would be needed.

Some difficulty could be experienced in Moffat and Rio Blanco Counties in recruiting additional physicians and in Moffat, Rio Blanco, and Routt Counties in recruiting additional registered nurses. None of the three counties has a major medical facility. Moffat and Rio Blanco Counties could have more difficulty recruiting additional health care specialists than Routt County because neither has a recreation development such as the ski resort at Steamboat Springs.

Local Government Finances

Revenue and Expenditure Projections. Table 8-33 compares projected operating expenditures with revenues which would accrue to individual communities in the study area at low-level. The Moffat and Routt County governments would experience significant revenues surpluses due to greatly increased property tax assessments. It is not known whether they would use these surpluses to increase their financial reserves, expand the range and level of services offered to county residents, or reduce local tax rates. Either of the latter two alternatives would result in a reduction of the projected revenue surpluses. The advent of a possible regional tax-sharing system such as that discussed in Chapter 2 would also reduce potential county surpluses by diverting a portion of county tax monies to municipal governments.

While Rio Blanco County is shown facing a potential operating deficit, revenues projections for Rio Blanco do not incorporate property taxes on future investmenst in shale oil facilities (see note to Table 8-33). In view of the magnitude of these investments (over $2 billion by 1990), it is certain that Rio Blanco County's long-term operating position would be favorable, but Rio Blanco County would face front-end financing problems. The county would have to provide services to thousands of shale oil plant construction workers before property tax revenues begin to flow from the completed plants.

The operating position of all municipal governments would be favorable under the low-level scenario.

Incremental Property and Sales Tax Revenues. Tables 8-34 through 8-38 highlight the major impacts of low-level development on local government finances. Table 8-34 describes increases in non-residential assessed valuation occurring at low-level as a result of new coal-related investments. Tables 8-35 through 8-37 relate these changes to trends in total assessed valuation, including increases in residential assessments due to mine-related population increases. Table 8-38 indicates increases in sales tax collections.

Captial Funds Requirements. The preceeding portion of this discussion has focused on local communities' projected requiremnts for operating funds

TABLE 8-33

LOW-LEVEL PROJECTED OPERATING BALANCES
1980-1990

	1980			1985			1990		
	Revenues	Expenditures	Surplus/deficit overrun/(short fall)	Revenues	Expenditures	Surplus/deficit overrun/(short fall)	Revenues	Expenditures	Surplus/deficit overrun/(short fall)
Counties									
Moffat	$3,507,217	$1,313,034	$2,194,183	$4,256,563	$1,622,990	$2,633,573	$4,731,633	$1,674,676	$3,056,957
Rio Blanco	1,713,758	1,934,613	1/	2,174,022	3,425,575	1/	2,400,141	3,169,138	1/
Routt	2,646,798	1,972,624	674,174	3,311,257	2,509,568	801,689	4,222,618	2,911,200	1,311,418
Cities									
Craig	1,468,092	1,266,004	202,088	1,982,793	1,796,643	186,150	2,259,351	1,903,750	355,601
Dinosaur	55,588	36,874	18,714	80,204	45,430	34,774	86,801	45,179	41,622
Meeker	1,084,349	661,113	423,236	2,080,090	1,238,957	841,093	2,168,425	1,127,724	1,040,701
Rangely	1,041,707	406,020	635,687	1,987,582	835,876	1,151,706	2,167,314	769,822	1,397,492
Hayden	336,826	204,854	131,972	513,922	293,374	220,548	744,081	374,902	369,179
Oak Creek	104,173	57,055	47,118	171,364	105,502	65,862	242,093	140,934	101,159
Steamboat Springs	2,635,476	1,967,973	667,503	3,555,989	2,764,891	791,098	4,369,609	3,327,182	1,042,427

1/ Rio Blanco's oil shale revenue has not been included since local authorities have not developed a formula for assessing this mineral. Local authorities state that existing formulas for property assessments would grossly misrepresent the assessed valuation. (Mr. Bloomfield, Rio Blanco County Assessor, telephone conversation, July 24, 1978).

TABLE 8-34

LOW-LEVEL PROJECTED INCREASES IN NON-RESIDENTIAL
ASSESSED VALUATION DUE TO MAJOR PRIVATE INVESTMENT

Sector County	Cumulative increases 1978-1980	 1978-1985	 1978-1990
Coal mines property			
Moffat	$ 6,723,000	$ 6,723,000	$ 6,723,000
Routt	2,460,000	4,200,000	4,200,000
Production			
Moffat	1,800,000	1,800,000	1,620,000
Routt	902,000	1,070,000	1,980,000
Power plants			
Moffat	10,800,000	10,800,000	10,800,000
Oil shale			
Rio Blanco	1/	1/	1/
Water reclamation			
Moffat	2/	2/	2/
Ski area expansion			
Routt	2,490,000	10,950,000	24,810,000
Total baseline assessed valuation			
Moffat	8,523,000	8,523,000	8,343,000
Routt	5,852,000	16,220,000	30,990,000

1/ It is impossible to project the property tax assessment on future oil shale facilities, since Rio Blanco County has not yet established the formula on which such assessments will be based. (Bloomfield, personal contact, 1978).

2/ Project assessments on water reclamation projects are not presented because final funding status (i.e., public or private investment) has not yet been resolved.

TABLE 8-35

LOW-LEVEL PROJECTED CUMULATIVE CHANGES IN ASSESSED VALUATION AND PROPERTY TAX REVENUES
1980

	1977 assessments		Change since 1977		Total		Mill levy		Property tax revenues
Moffat	60,246,860	+	1,521,000	=	61,767,860	X	.1565	=	966,667
Craig	14,968,190	+	803,130	=	15,774,320	X	.16	=	252,389
Dinosaur	299,800	+	76,050	=	375,850	X	.12	=	4,510
Rio Blanco	201,564,840	+	5,176,500	=	204,640,000	X	.0055	=	1,122,227
Meeker	5,870,240	+	2,950,605	=	8,820,845	X	.0088	=	77,623
Rangley	4,080,090	+	1,254,125	=	5,374,215	X	.02482	=	133,388
Routt	103,235,320	+	8,190,000	=	111,420,000	X	.01574	=	1,753,834
Hayden	2,389,880	+	1,228,500	=	3,618,380	X	.02605	=	94,258
Oak Creek	1,232,310	+	327,600	=	1,559,910	X	.024	=	37,437
Steamboat Springs	34,299,300	+	3,357,900	=	37,657,200	X	.00828	=	311,801

TABLE 8-36

LOW-LEVEL PROJECTED CUMULATIVE CHANGES IN ASSESSED VALUATION AND PROPERTY TAX REVENUES
1985

	1977 assessments		Change since 1977		Total		Mill levy		Property tax revenues
Moffat	60,246,360	+	13,669,500	=	73,916,360	X	15.65	=	1,156,791
Craig	14,968,190	+	7,244,835	=	22,130,025	X	16	=	355,408
Dinosaur	299,800	+	683,475	=	983,275	X	12	=	11,799
Rio Blanco	201,564,840	+	42,060,900	=	243,620,000	X	55	=	1,339,910
Meeker	5,870,240	+	23,974,713	=	29,844,953	X	8.8	=	262,635
Rangley	4,080,000	+	10,515,225	=	14,595,315	X	24.82	=	362,255
Routt	103,235,320	+	28,818,000	=	132,050,000	X	15.74	=	2,078,519
Hayden	2,389,880	+	4,322,700	=	6,712,579	X	26.05	=	174,862
Oak Creek	1,232,310	+	1,152,720	=	2,385,030	X	24	=	57,240
Steamboat Springs	34,299,300	+	11,815,380	=	46,114,680	X	8.28	=	381,829

TABLE 8-37

LOW-LEVEL PROJECTED CUMULATIVE CHANGES IN ASSESSED VALUATION AND PROPERTY TAX REVENUES
1990

	1977 assessments		Change since 1977		Total		Mill levy		Property tax revenues
Moffat	60,246,860	+	31,083,000	=	91,329,860	X	15.65	=	1,429,312
Craig	14,968,190	+	15,473,990	=	31,442,180	X	16	=	503,074
Dinosaur	299,800	+	1,554,150	=	1,853,950	X	12	=	22,247
Rio Blanco	201,564,840	+	91,013,700	=	292,570,000	X	5.5	=	1,609,181
Meeker	5,870,240	+	51,877,804	=	57,748,049	X	8.8	=	508,182
Rangley	4,080,080	+	22,753,425	=	26,833,515	X	24.82	=	666,007
Routt	103,235,320	+	64,716,000	=	167,950,000	X	15.74	=	2,643,553
Hayden	2,389,880	+	9,707,400	=	12,097,280	X	26.05	=	315,134
Oak Creek	1,232,310	+	2,588,640	=	3,820,950	X	24	=	91,702
Steamboat Springs	34,299,300	+	26,533,560	=	60,832,860	X	8.28	=	503,696

TABLE 8-38

LOW-LEVEL PROJECTED RETAIL SALES TAX REVENUES
(thousands of dollars)

County City	1980	1985	1990
Moffat	$1,980	$1,897	$2,077
Craig	756	975	1,065
Dinosaur	9	12	13
Rio Blanco 1/			
Meeker	316	523	482
Rangely	607	1,005	930
Routt 1/			
Hayden	77	102	126
Oak Creek	18	24	30
Steamboat Springs	944	1,238	1,536

1/ Rio Blanco and Routt Counties do not levy a sales tax.

TABLE 8-39

LOW-LEVEL PROJECTED CAPTIAL NEEDS AND COST
(thousands of dollars)

City	Activity		
	Fire trucks	Water systems	Sewer facilities
Steamboat Springs	150	1,976	9,696
Meeker	150	-	7,272
Rangely	75	-	-

at low-level. Table 8-39, which is based on projected capital facilities requirements (see Local Services) and estimated facilities costs, contains estimates of these communities' requirements for capital funds between 1977 and 1990.

Most communities should be able to raise the required funds internally, i.e., out of projected operating surpluses or by bond sales. Probable exceptions include Meeker and Steamboat Springs, which face projected total capital expenditures of $7.4 million and $11.8 million, respectively, during 1978-1990. Possible sources of financial assistance for these projects include the Colorado General Assembly's project grants under the Federal Water Pollution Control Act, and grants or loans from the U.S. Commerce Department Economic Development Administration.

Impact on Colorado State Finances. The total impact on state finances cannot be identified due to the limitations of the model used in this analysis. However, it is possible to identify specific revenue increases from sales taxes and mineral royalties and state income taxes paid by employees.

In the benchmark years of 1980, 1985, and 1990 the state would receive $21,895,684, $28,188,863, and $26,026,190, respectively, from these sources. The revenue increases above the 1977 level for these three state revenue generating items would be an estimated $7,965,750, $14,258,929, and $12,096,256 for the three benchmark years, respectively.

Utilities

Purchase of electricity from companies outside the region would be necessary if demand for electricity in northwest Colorado would exceed the power generating capacity of the electricity suppliers, the Moon Lake Electric Association and the Colorado-Ute Electric Association, the latter of which supplies power to the Yampa Valley and White River Electric Associations.

Increased pipeline capacity for natural gas would soon be needed to meet customer demand. In the short run, facility constraints would create distribution problems for natural gas companies because current demand for natural gas is almost at pipeline capacity and 2 to 3 years would be needed for pipeline capacity to be increased. However, regional population by 1980 would increase by only 733, an increase of 3 percent over the 1977 population. There would, therefore, be adequate lead time to increase pipeline capacity to meet projected demand by 1985 and 1990. In addition to increasing pipeline capacity, additional natural gas would also be needed.

Transportation Networks

The following transportation developments are anticipated from continued development of existing leases with ongoing mining operations.

Highways

Even without development of additional federal coal, many of the highways need to be upgraded and improved because of recent expansion of coal mining, oil and gas developments, and oil shale projects. Most of the existing highways were designed for lightweight traffic and are not suitable for industrial hauling.

The following highway construction projects are proposed by the Colorado Department of Highways in their Draft Five Year Highway Construction Plan for Fiscal Years 1979-1983. These projects would depend upon adequate federal and state funding.

U.S. Highway 40 west of Steamboat Springs would be upgraded for 2 miles and an interchange would also be constructed at the Mt. Werner turnoff to the LTV ski run area. Colorado 13 from Axial Basin to Meeker would be resurfaced for 21 miles. Also, 13 miles of Colorado 13 north of Craig would be widened. Colorado 64 west of Rangely would be reconstructed for 2 miles and resurfaced for 16 miles. Colorado 131 would be resurfaced for 10 miles north of Oak Creek. Other State Highway projects through 1990 would be selected on the basis of traffic volumes, serviceability of the road, and safety information on the road. Also, several county and private roads branching off of the state highways would be proportionately upgraded as funding permits.

Table 8-40 presents projected increases in traffic volumes at low-level at selected points within the study area. This data shows most traffic increases in and near major communities in the study area and smaller increases in the rural areas. Average vehicle-miles per day would increase from 525,000 in 1976 to 570,000 by 1980, 626,000 by 1985, and 685,000 by 1990.

Vehicle registrations in the Routt, Moffat and Rio Blanco counties would increase from the 1976 combined total of 25,781 to 33,100 in 1980, to 46,500 in 1985, and to 48,500 in 1990. Tables 8-3 and 8-4 indicate development of new mining related roads. Generally, the impacts at low-level would not be of major significance. Accidents and maintenance of roads would increase at a stable rate. In 1977 there were 1,926 traffic accidents in the three-county study area. Traffic volume increases at low-level would also result in more accidents, by 1980, 2,090 accidents per year in the study area, 2,300 by 1985, and 2,510 by 1990.

Railroads

The amount of rail traffic generated by the region would be expected

TABLE 8-40

INCREASES IN TRAFFIC VOLUMES IN SELECTED POINTS
IN THE STUDY AREA AT LOW-LEVEL
(UNITS: AVERAGE DAILY TRAFFIC)

Location		1976	1980	1985	1990
US 40	at Utah State Line	1,300	1,380	1,480	1,570
US 40	W/o Dinosaur	1,550	1,640	1,760	1,880
US 40	E/o Dinosaur	1,100	1,170	1,250	1,330
US 40	E/o Rd to Blue Mtn	960	1,020	1,090	1,160
US 40	W/o Jct SH 318	1,000	1,060	1,140	1,210
US 40	E/o Jct SH 318	1,200	1,270	1,360	1,450
US 40	W/o W Jct SH 13	1,800	1,910	2,043	2,180
US 40	E/o W Jct SH 13	4,750	5,040	5,390	5,750
US 40	W/o E Jct SH 13	6,600	7,000	7,490	7,990
US 40	E/o E Jct SH 13	5,200	5,720	6,370	7,020
US 40	W/o Hayden	2,750	3,030	3,370	3,710
US 40	E/o Hayden	2,650	2,920	3,250	3,580
US 40	W/o Milner	2,600	2,860	3,200	3,510
US 40	W.C.L. Steamboat Springs	5,800	6,496	7,370	8,240
US 40	S.C.L. Steamboat Springs	7,200	8,208	9,468	10,730
US 40	5 Mi S/o Jct 131	1,950	2,184	2,480	2,770
SH 131	S/o Jct US 40	1,200	1,320	1,470	1,620
SH 131	N/o Oak Creek	1,100	1,212	1,350	1,490
SH 131	N/o Phippsburg	950	1,045	1,160	1,280
SH 131	S/o Phippsburg	750	825	920	1,010
SH 131	S/o Yampa	630	693	770	850
SH 13	Colorado-Wyoming State Line	630	680	740	810
SH 13	N.C.L. Craig	1,800	1,940	2,124	2,300
SH 13	S/o US 40	2,400	2,592	2,830	3,070
SH 13	N/o Hamilton	1,100	1,170	1,250	1,330
SH 13	S/o Hamilton	1,100	1,170	1,250	1,330
SH 13	at Rio Blanco-Moffat Co.Line	860	910	980	1,040
SH 13	E.C.L. Meeker	2,650	2,810	3,010	3,210
SH 13	E/o Jct SH 64	1,950	2,030	2,130	2,220
SH 13	S/o Jct SH 64	1,400	1,456	1,530	1,600
SH 317	E/o Jct SH 13	150	168	190	210
SH 394	S.C.L. Craig	2,650	3,021	3,480	4,510
SH 394	2 Mi S/o Craig	730	790	860	930
SH 64	W/o Jct SH 13	950	990	1,040	1,080
SH 64	4 Mi W/o Jct SH 13	640	670	700	730
SH 64	E/o Jct SH 139	840	880	920	960
SH 64	W/o Jct SH 139	1,450	1,510	1,580	1,650
SH 64	W.C.L. Rangely	2,750	2,860	3,000	3,140
SH 64	W/o Blue Mtn Rd	1,850	1,924	2,020	2,110
SH 64	E/o Bonanza Rd	790	820	860	900
SH 64	at Rio Blanco-Moffat Co.Line	790	820	860	900
SH 139	S/o SH 64	640	740	870	1,000

SH: State Highway
N/o: North of
S/o: South of
E/o: East of
W/o: West of
N.C.L.: North City Limits
S.C.L.: South City Limits
E.C.L.: East City Limits
W.C.L.: West City Limits

Source: Colorado State Department of Highways

to increase from the present annual level of 105,120 carloads to 127,000 carloads in 1990. This is 56 percent of the number of carloads generated in 1990 by the mid-level of development and assumes 80 percent of the production is shipped by rail. Approximately 1,588 round trips (3,176 individual train movements) of unit trains 80 cars in length would be required to move this amount of traffic.

The region's railroad system would be upgraded as indicated in Tables 8-3, 8-4, and 8-5. Consideration of the present rate of population growth has led the local council of governments (NWCCOG-Region 12) and others to urge the D&RGW railroad to resume passenger service from Denver into northwestern Colorado. It should be pointed out that all major non-subsidized intercity rail passenger operations, other than the Rio Grande Zephyr which operates between Denver and Salt Lake City, are the subject of abandonment proceedings before the Interstate Commerce Commission (this refers to the Southern Railways "Southern Crescent", the Rock Island's "Rocket", and Southern Pacific's "Peninsula Service".). Reinstitution of a non-subsidized rail passenger service to the region would be unlikely.

Coal produced in the West Central Colorado and Central Utah regions moving to destinations to the east would have greater flexibility in the choice of routing since there would be surplus capacity on the Dotsero to Denver main-line. Oil shale developers consider rail service essential to their plans. Superior Oil favors a rail line from Piceance Creek up to the Union Pacific system in Wyoming with a flatter ruling grade than exists on the D&RGW system into Denver, however Union Pacific has no plans for such a line. See Tables 8-3, 8-4, and 8-5 for further information on new railway development.

As a result of low-level increases in train and auto traffic, the incidence of auto-train collisions at unseparated grade crossings would increase. The cumulative hazard ratings for crossings in the study area are 8.13 for 1976, 8.21 by 1980, 8.30 by 1985, and 8.40 by 1990. Hazard ratings are the number of auto-train collisions expected in a 5-year period.

As a result of low-level increases in train traffic, the average daily vehicle waiting time at unseparated grade crossings would increase. Assuming a three-minute delay per train, daily vehicle waiting time at low-level would increase from the present 12 minutes per day to 14 minutes per day by 1980, 15 minutes by 1985, and 13 minutes by 1990. This would be especially significant to emergency vehicles, which would have no alternate route. The impact to emergency services is difficult to quantify because there is no data on the probability of an emergency vehicle being delayed in the study area.

HIGH-LEVEL SCENARIO

The high-level scenario includes both an analysis of impacts for cumulative development at high-level and for that increment of cumulative development attributable to additional federal coal at high-level. Cumulative high-level development includes existing private, state, and federal coal (low-level) and additional federal coal at high-level. New federal coal at high-level includes short-term leases and mine plan approvals (additional federal coal at mid-level); and preference right lease areas (PRLAs) and federal areas of interest (FAIs - areas of forseeable future development of federal coal once a new federal leasing program is developed).

Areas of development at high-level are shown on Map 1-3 (Appendix C). Table 8-41 provides detailed information pertaining to coal mining at high-level. Table 8-42 shows acres disturbed from additional federal coal development at high-level. Tables 8-43 and 8-44 show data for cumulative development at high-level.

In the periods 1978-80, 1981-85, and 1986-90, the projected acreage disturbance for additional federal coal at high-level are 1,820 acres, 8,305 acres, and 15,875 acres, respectively, for a total of 26,000 acres. The acreage disturbed for cumulative development at high level is 8,110 acres, 15,760 acres, and 21,490 acres, respectively, for a total of 45,360 acres.

Projected Mining Activities Other Than Those Included in Mid-level

Consolidation Coal Company

This company, a wholly-owned subsidiary of the Continental Oil Company, holds seven issued federal coal leases, C-093713, C-245, C-1545, C-1546, C-093714, C-093715, and C-093716, covering approximately 10,000 acres in the Ninemile Gap area north of Meeker. The company is currently conducting an exploration program on these tracts. An underground mine plan has not yet been formulated and is dependent upon the issuance of PRLAs. Production from these existing leases and PRLAs are included in the high-level production figures.

TABLE 8-41

PROJECTED CUMULATIVE DEVELOPMENT FOR
NORTHWEST COLORADO (HIGH-LEVEL)

Existing and projected	1977	1980	1985	1990
Coal mines	12	28	47	45
Power plant capacity (megawatts)	450	1,210	1,590	2,590
Tons of coal mined (1,000s of tons)	--	20,755	43,200	56,500
Approximate population	25,929	31,000	56,500	74,500
Miles of new railroad	--	27	55	110
Miles of new road	--	30	115	240
Miles of new powerlines	110	110	110	235

TABLE 8-42

ACRES DISTURBED AND REVEGETATED AS A RESULT OF POSSIBLE NEW DEVELOPMENT OF FEDERAL COAL AT HIGH-LEVEL

	1978-80	1981-85	1986-90	Total
Surface mines	470	3,150	8,660	12,280
Surface mines revegetated	100	470	3,150	3,720
Powerline rights-of-way disturbed	-	-	1,500	1,500
Powerline rights-of-way revegetated	-	-	-	-
Roads 1/ 2/	420	1,380	2,075	3,875
Surface mine 1/ facilities and related rights-of-way	-	1,000	-	1,000
Underground mines 1/ 3/ and related rights-of-way	500	700	100	1,300
Power plants 1/ 8/	-	380	1,000	1,380
Railroads 1/ 6/	-	225	900	1,125
Population 1/ 7/	430	1,470	1,640	3,540
Total disturbed 5/	1,820	8,305	15,875	26,000
Total revegetated 4/	100	470	3,150	3,720
Total permanently removed	1,350	5,155	5,715	12,220

1/ This acreage considered permanently removed from production for the time frame of this report.
2/ Includes haul roads, access roads, and coal exploration trails.
3/ Does not include subsidence.
4/ Includes acreage revegetated from mine and powerline disturbance.
5/ The total disturbed acreage includes all those in footnote 1/ and acres disturbed from surface mines and powerlines.
6/ There are 18 acres per mile required for construction of a railroad (150' right-of-way).
7/ There are 100 acres required per 1,000 population increase.
8/ One acre of land is required per megawatt of generating capacity for power plants.

TABLE 8-43

ACRES DISTURBED AND REVEGETATED AS A RESULT OF
CUMULATIVE COAL DEVELOPMENT AT HIGH-LEVEL

Activity	1978-80	1981-85	1986-90	Total
Surface mines	3,280	8,430	13,490	25,200
Surface mines revegetated	200	3,280	8,430	11,910
Powerline rights-of way disturbed	1,880	--	1,500	3,380
Powerline rights-of way revegetated	--	1,880	--	1,880
Roads 1/ 2/	630	1,800	2,600	5,030
Surface mine facilities and related rights-of-way 1/	700	1,200	--	1,900
Underground mines and related rights-of-ways 1/ 3/	620	900	100	1,620
Power plants 1/ 8/	--	380	1,000	1,380
Railroads 1/ 6/	490	500	1,000	1,990
Population 1/ 7/	510	2,550	1,800	4,860
Total disturbed 5/	8,110	15,760	21,490	45,360
Total revegetated 4/	200	5,160	8,430	13,790
Total permanently removed	2,950	7,330	6,500	16,780

1/ This acreage considered permanently removed from production for the time frame of this report.
2/ Includes haul roads, access roads, and coal exploration trails.
3/ Does not include subsidence.
4/ Includes acreage revegetated from mine and powerline disturbance.
5/ The total disturbed acreage includes all those in footnote 1/ and acres disturbed from surface mines and powerlines.
6/ There are 18 acres per mile required for construction of railroad (150' right-of way).
7/ There are 100 acres required per 1,000 population increase.
8/ One acre of land is required per megawatt of generating capacity for power plants.

TABLE 8-44

HIGH-LEVEL SCENARIO FOR COAL PRODUCTION IN NORTHWEST COLORADO 1/

Activity	Projected coal production (1000s of tons)			Total acres of disturbance 2/				Total acres revegetated			
	1980	1985	1990	1978-80	1981-85	1986-90	Total	1978-80	1981-85	1986-90	Total
Low-level developments	16,595	18,195	15,870	6,290	7,455	5,615	19,360	100	4,690	5,280	10,070
Short-term lease areas and mine plan approvals	3,660	9,255	12,430	1,610	4,345	3,455	9,410	100	470	2,030	2,600
Preference right lease areas 3/	500	5,750	10,600	210	1,730	4,400	6,340	-	-	400	400
Federal Areas of Interest	-	10,000	17,400	-	2,230	8,020	10,250	-	-	720	720
Total	20,755	43,200	56,300	8,110	15,760	21,490	45,360	200	5,160	8,430	13,790

1/ Data listed for years 1980, 85, and 90 are for those specific years; Data listed for time periods 1978-80, 1981-85, and 1986-90 are cumulative for the indicated periods.
2/ Average acreage per year disturbed per million tons of coal mined equals 100 acres. This figure is for coal mines on the Wadge coal seam; mines with thicker seams or multiple seams will create less acreage disturbance per million tons of coal mined.
3/ Includes production from adjacent existing federal leases.
4/ Assume 100 ton capacity cars for all cars in a unit train with 80 cars per unit train.
5/ Ten gallons of water is required per ton of coal produced.
6/ There is a requirement of 175 acre-feet per year of water per 1,000 population increase.

TABLE 8-44 (Cont.)

HIGH-LEVEL SCENARIO FOR COAL PRODUCTION IN NORTHWEST COLORADO 1/

Activity	Permanent Employment			Unit trains per 4/ year			Annual water requirements for mine and coal handling (acre-feet/year) 5/			Annual water requirements for population increase (urban) (acre-feet/year) 6/		
	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990
Low-level development	1,565	2,200	2,110	1,660	1,820	1,590	510	550	490	130	1,950	2,220
Short-term lease areas and mine plan approvals	695	1,540	2,090	370	930	1,240	110	280	380	540	1,870	2,570
Preference right lease areas 3/	150	880	1,300	50	780	1,060	15	180	330	180	630	1,510
Federal Areas of Interest	-	980	1,600	-	800	1,390	-	310	530	-	700	1,870
Total	2,410	5,600	7,100	2,880	5,590	5,870	635	1,320	1,730	850	5,150	8,170

1/ Data listed for years 1980, 85, and 90 are for those specific years; Data listed for time periods 1978-80, 1981-85, and 1986-90 are cumulative for the indicated periods.
2/ Average acreage per year disturbed per million tons of coal mined equals 100 acres. This figure is for coal mines on the Wadge coal seam; mines with thicker seams or multiple seams will create less acreage disturbance per million tons of coal mined.
3/ Includes production from adjacent existing federal leases.
4/ Assume 100 ton capacity cars for all cars in a unti train with 80 cars per unit train.
5/ Ten gallons of water is required per ton of coal produced.
6/ There is a requirement of 175 acre- feet per year of water per 1,000 population increase.

Moon Lake Electric Association

This company plans on mining coal by surface and underground methods from existing federal lease C-023703, and two PRLAs located 6 miles northeast of Rangely, Colorado. This operation would consist of two underground mines, with mine portals being constructed on lease C-023703 and mining advancing into and undermining most of the two PRLAs. It is assumed that the surface and underground mines would not be put into operation until a new federal leasing program is developed and a competitive lease application and/or the two PRLAs are issued. Anticipated production includes 1.5 million tons per year from each underground mine and 700,000 tons per year from the surface mine, totaling 3.7 million tons per year. No date for mine start-up has been established. These mines would produce coal for Moon Lake Electric Association's planned Rangely Power Plant. Production from the existing lease and the two PRLAs are included in the high-level production figures.

Utah International Inc.

Utah International Inc. plans on mining coal by surface and underground methods from existing federal lease C-0123476, a PRLA, and state lands. This operation would be located approximately 7 miles west of the town of Axial, Colorado, via local roads. It is assumed that the existing lease would not be developed until the federal leasing program is revised and the PRLA is issued. The surface mine would extract the six upper seams and their splits (seams J through O), producing 2 million tons per year. The underground mine would develop the G seam, producing about 1.5 million tons per year. Anticipated mine life is 30 years.

Preference Right Lease Areas and Federal Areas of Interest

Production from preference right lease areas would arise from approximately seven mines. This includes one surface and six underground mines. Approximately nine mines are anticipated to be developed in the Federal Areas of Interest, most of which will be surface mines. Approximate production, acres disturbed, and other associated information is shown in Table 8-44 for these areas.

Non Coal-Related Development

No proposals are on record for non-coal related development other than that discussed in the mid-level scenario.

Coal-Related Development

For the purpose of this study, Moon Lake Electric Association's

planned Rangely Power Plant northeast of Rangely, Colorado, is included in the high-level 1990 time period. The generating capacity would be in the 250-1,000 megawatt range, depending on the market. It is assumed that this installation would have a 1,000 megawatt capacity. At maximum output, this plant would use 3.7 million tons of coal, which would be produced by Moon Lake's planned underground and surface mines discussed earlier. This additional generating capacity would increase the 1990 total power plant capacity of northwest Colorado to 2,590 megawatts. Unit 3 of the Craig Power Plant (380 megawatts) is also included in the high-level projections.

Allowing for development of new federal coal at a practicable rate could result in a full, high-level production rate of 56.5 million tons per year by 1990. A breakdown of the distribution of this production is listed below.

42.25	million tons shipped out of study area by railroad
7.60	million tons used for electrical generation at Hayden Power Plant (2 units), Craig Power Plant (3 units), and Rangely Power Plant (1 unit)
1.50	million tons for domestic use
5.15	million tons, which represent a 10 percent increase in domestic and electrical use for unforseen changes
56.50	million tons

As shown in Table 8-41, coal production of 56.5 million tons is approached in 1990. Production projections for 1980 are 20,755,000 tons, with 43,200,000 tons mined in 1985.

Topography

Long-term developments such as mine buildings and shop facilities, railroads, and housing developments would cause minor alterations to the topography in coal mining areas (southwest Routt County, southeast Moffat County, the area north of Rangely and the area northeast of Meeker) and areas of population growth such as Meeker, Rangely, Craig, Hayden, and Steamboat Springs. These changes are considered permanent for the time frame of this report. These disturbances would affect 2,950 acres by 1980, an additional 7,330 acres by 1985, and an additional 6,500 acres by 1990 for a total of 16,780 acres permanently disturbed by 1990. Of this acreage, 1,350 acres would be disturbed due to the additional development of federal coal by 1980, an additional 5,155 acres by 1985, and an additional 5,715 acres by 1990 for a total of 12,220 acres permanently disturbed by 1990.

Mining would result in temporary disturbances to the topography in the areas of coal mining. The nature of these disturbances during mining and after reclamation are described in Chapter 4, Topography. Temporary disturbance would occur over 5,160 acres by 1980, an additional 8,430 acres by 1985, and an additional 14,990 acres by 1990 for a total of 28,580 acres. Temporary disturbances of surface area due to the additional development of federal coal would be 470 acres by 1980, an additional 3,150 acres by 1985, and an additional 10,160 acres by 1990 for a total of 13,780 acres.

Subsidence and related earth fractures, including a general lowering of the surface, opening of tension cracks, and formation of compression features such as fracture bulges and small anticlines, may occur above underground mines as a result of the removal of one or more coal beds. For further discussion of subsidence, see Chapter 4, Topography.

In the absence of specific mining plans, the magnitude of subsidence-related impacts and the area affected cannot be determined. Most underground mining in the study area would utilize continuous underground room and pillar methods (Table 1-1). Subsidence in conjunction with the room and pillar method is expected to be minimal. Some tension cracks would probably reach the surface, but no significant lowering of the surface during or following mining should occur. Subsidence as a result of the longwall method, which removes large blocks of coal and encourages roof collapse in the mined-out areas, may reach a few tens of feet, but should average less than 10 feet. Relatively limited use of the longwall method is planned.

So far as could be determined, possible subsidence and related fracturing as a result of cumulative development at high-level would jeopardize no existing structures or public roadways. Any changes in topography should be subtle and have minimal effect on surface drainage. Cracks should fill rapidly with debris and sediment and should present no

greater hazard to wildlife than existing steep-sided gullies or arroyos. The effects of subsidence on ground-water are described in Water Resources.

Paleontology

Impacts to paleontological resources would consist of losses of plant, invertebrate, and vertebrate fossil materials for scientific research, public education (interpretive programs), and to other values. Losses would result from destruction, disturbance, or removal of fossil materials as a result of coal mining activities, unauthorized collection, and vandalism. Theoretically, the larger acreage disturbed at high-level than at mid- or low-level development would suggest that there would be greater losses to paleontological resources, but no data on the concentration and sensitivity of such resources exists so any assessment of loss is impossible.

A beneficial impact of development would be the exposure of fossil materials for scientific examination and collection which otherwise may never have occurred except as a result of overburden clearance and excavation.

Losses of paleontological materials due to unauthorized collecting and vandalism would increase as population increases, but no data exists to correlate losses with general population increase.

Losses to paleontological values due to coal-related operations would occur especially in the vertebrate fossil-bearing formations in areas of coal development. These values are mammalian and other vertebrate fossils of the Wasatch and Fort Union Formations 5 to 10 miles west of Craig, Colorado; of the Fort Union and Lance Formations 10 miles northeast of Craig, and other unspecified vertebrate fossils of the Bridger Formation 5 to 10 miles south of Craig.

The major impact to mineral resources would be the removal of a cumulative total 449 million tons of coal from the study area by 1990. Coal production in the study area would be 20.8 million tons per year by 1980, 43.2 million tons per year by 1985, and 56.3 million tons per year by 1990. This represents 1.2 percent of the 38 billion tons of measured, indicated, and inferred coal reserves in the study area (Landis 1959). Development of additional federal coal at high-level would account for 224 million tons of the total coal mined by 1990. Coal production from the development of additional federal coal would be 4.2 million tons per year by 1980, 25.0 million tons per year by 1985, and 40.4 million tons per year by 1990.

Approximately 207 million tons of coal would not be recovered because of losses inherent in the method used to extract the coal. Approximately 128 million tons of this unrecovered coal would be due to additional development of federal coal at high-level. Underground mining would recover approximately 50 percent of the economically minable coal, surface mining methods approximately 90 percent of the economically minable coal.

Impacts stemming from cumulative development at high-level should be the same in kind as those described in Chapter 4 but larger in proportion to the increment of coal production over cumulative mid-level rates.

Ground Water

The approximate areal extent of aquifers that would be removed under cumulative high-level coal development during the time frames indicated in this report is summarized in Table 8-45.

TABLE 8-45

AQUIFERS DISTURBED

Resource	1978-80	1980-85	1986-90	1978-90
Approximate area of aquifers removed at cumulative high-level development in square miles (sq-mi)	7.6	25.0	41.6	74.2
Percent of total coal area disturbed	0.8	2.5	4.1	7.4
Percent of study area disturbed	0.09	0.03	0.5	0.8
Approximate area of aquifers removed for development of additional federal coal (sq-mi)	1.2	10.9	28.1	40.2

The above tabulation shows that cumulative development at high-level would remove about 0.8 percent of the shallow ground-water aquifers in the study area by 1990.

The total area disturbed at cumulative high-level production is small compared to the size of the study area. No significant impact on the regional ground-water system is expected. Local impacts would be the same as described in Chapter 4, only more areas would be adversely affected.

Surface Water

All natural stream channels would be altered or removed within

areas disturbed by cumulative high-level coal development. The percentage of stream channels affected during the time frames indicated in this report are as follows:

TABLE 8-46

NATURAL STREAM CHANNELS DISTURBED

Resource	1978-80	1981-85	1986-90	1978-90
Approximate total surface area disturbed at cumulative high-level development (sq-mi)	12.7	24.6	33.6	70.9
Percent of total coal area in which stream channels would be altered or removed	1.3	2.4	3.4	7.1
Percent of study area in which stream channels would be altered or removed	0.14	0.28	0.38	0.80
Approximate total surface area disturbed for development of additional federal coal (sq-mi)	2.9	13.0	24.8	40.7

Although stream channels would be altered or removed from 70.9 square miles, only 0.80 percent of the entire study area would be disturbed, which should not significantly impact the regional surface-water system. Development of additional federal coal would account for 40.7 square miles of this. Local impacts related to alteration or removal of stream channels should be similar to those occurring under mid-level development.

Consumptive use of water by mining-related activities at cumulative development at high-level (Table 8-48) is summarized in Table 8-47.

Degradation in water quality from leaching of replaced spoil materials would probably have essentially the same local effects as at low-level. About 95 percent more area would be impacted, however. Dissolved solids load in the Yampa River from this source is expected to be increased about 0.2 percent due to additional federal coal by 1980, about 1.5 percent by 1985, and about 2.3 percent by 1990. The increase probably could not be measured by normal sampling methods.

The estimated increase in dissolved solids concentration in the Yampa and Colorado Rivers from mining and related activities at cumulative

TABLE 8-47

WATER USE BY MINING-RELATED ACTIVITES AT
CUMULATIVE DEVELOPMENT AT HIGH-LEVEL

	1980	1985	1990
Consumptive use (ac-ft)	19,600	27,700	44,000
Percent of runoff from report area	1.2	1.6	2.6
Percent increase in consumptive use due to development of additional federal coal	2	42	127

high-level development (Table 8-48) is summarized in Table 8-49. The higher concentrations of dissolved solids should have no significant impact on aquatic biology, consumptive uses or water-treatment facilities within the study area. The additional dissolved solids load would seriously impact the Colorado River, however, because this load currently exceeds desirable limits.

Interruption of premining ground-water flow by dewatering of mines and by modification of flow patterns by replaced spoil materials would tend to lower water levels in wells adjacent to mines and dry up some springs. These effects, however, should be local and generally short-term. The top of the zone of saturation should return to approximate premining levels following completion of mining. Restoration of locally perched ground-water conditions, however, would be difficult and probably would be only partially effective in reestablishing premining conditions. As a result, some springs may be permanently lost. Although no complete inventory of wells and springs is available for the study area, cumulative development at high-level would probably adversely impact no more than 1 percent of existing water supplies.

Degradation in water quality would occur from leaching of replaced spoil materials in surface-mined areas and from intercirculation of ground waters between aquifers connected by permeable spoil materials or by vertical fracturing associated with underground mining. The effects would be long term and probably would increase dissolved solids concentrations locally to about 2,500 to 3,000 mg/l. This water would be suitable for use by livestock and wildlife, but is not recommended for domestic use. Dissolved solids load in the Yampa River from this source would probably increase from about 11,000 tons/year in 1980 to about 18,000 tons/year by 1990 as a result of cumulative high-level development. Municipal wastes, coupled with the above sources of pollution, would increase the weighted average of dissolved solids in the Yampa River by about 5.4 percent by 1990. This moderate increase should

TABLE 8-48

EXISTING AND FUTURE CONSUMPTIVE WATER USE AND WATER QUALITY IN YAMPA RIVER SUBBASIN
AT CUMULATIVE DEVELOPMENT AT HIGH-LEVEL

	Supply, consumption, and quality categories	Present	1980	1985	1990
1	Total undepleted supply (ac-ft) 1/	1,702,400	1,702,400	1,702,400	1,702,400
2	Consumptive use at low-level development (Table 8-8) (ac-ft)	116,100	130,200	188,100	195,000
3	Net discharge at low-level development (ac-ft)	1,586,300	1,572,200	1,514,300	1,507,400
4	Additional consumptive use attributable to development of additional federal coal at high-level				
5	Additional power plants (ac-ft)	--	--	5,700	20,700
6	Municipal and rural (ac-ft) 2/	--	280	1,700	2,700
7	Mining operations (ac-ft)	--	130	830	1,240
8	Total (sum of lines 5,6,and 7) (ac-ft)	--	410	8,230	24,640
9	Net discharge at cumulative high-level development (line 3 less line 8) (ac-ft) 3/	1,586,300	1,571,800	1,506,100	1,482,800
10	Dissolved solids in Yampa River at low-level development (Table 8-8) (tons)	420,400	420,400	437,700	438,800
11	Additional increase in dissolved solids load attributable to development of additional federal coal at high-level				
12	Municipal wastes (tons) 4/	--	160	930	1,480
13	Mining operations (tons)	--	1,000	6,500	10,000
14	Less load removed by consumptive use of water in power Plants (tons)	--	--	1,240	4,500
15	Total (sum of lines 12,13, and 14) (tons)	--	1,160	8,670	15,980
16	Net dissolved solids load in Yampa River at cumulative high-level development (line 10 plus line 15) (tons)	420,400	421,600	446,400	454,800
17	Discharge weighted average of dissolved solids in Yampa River at low-level development (Table 8-8) (mg/l)	194.9	196.7	212.6	214.1
18	Discharge weighted average of dissolved solids in Yampa River at cumulative high-level development (mg/l)	194.9	197.3	218.0	225.6
19	Increase in dissolved solids in Yampa River as a result of development of additional federal coal at high-level (mg/l)	0 5/	0.6	5.4	11.5
20	Increase in dissolved solids in Colorado River below Hoover Dam at low-level development (mg/l) 6/	0 5/	1.0	6.4	7.0
21	Increase in dissolved solids in Colorado River below Hoover Dam at cumulative high-level development (mg/l) 7/	0 5/	1.1	7.7	10.0
22	Increase in dissolved solids in Colorado River below Hoover Dam as a result of development of additional federal coal at high level (mg/l)	0 5/	0.1	1.3	3.0

1/ Irons and others, 1965.
2/ Based on use of 150 gal/day/person with 50 gal/day consumed and 100 gal/day returned to streams as sewage. Population projections from Table 1-5.
3/ No action other than power plants under construction.
4/ Based on 100 gal/sewage/day/person and increase in dissolved solids load of 200 mg/l.
5/ Present is assumed to be base level against which future changes are compared.
6/ Including both the effects of diversions and increased dissolved sclids loading.

TABLE 8-49

INCREASES IN DISSOLVED SOLIDS IN THE YAMPA AND COLORADO RIVERS FROM DEVELOPMENT OF ADDITIONAL FEDERAL COAL AT HIGH-LEVEL

	1980	1985	1990
Estimated increase in dissolved solids concentration in Yampa River from development of additional federal coal at high-level (mg/l)	0.6	5.4	11.5
Percent increase in dissolved solids concentration in Yampa River from development of additional federal coal at high-level	0.3	2.5	5.4
Estimated increase in dissolved solids concentration in Colorado River from development of additional federal coal at high-level (mg/l)	0.1	1.3	3.0
Percent increase in dissolved solids concentration in Colorado River from development of additional federal coal at high-level	0.01	0.19	0.44

have no appreciable impact on aquatic biology, consumptive uses, or water treatment facilities within the study area. The corresponding increase in dissolved solids concentration in the Colorado River below Hoover Dam of about 3.0 mg/l by 1990 (Table 8-48), however, is considered to be significant, even though it represents an increase of only 0.44 percent.

Water losses from interception of runoff and storage of water in impoundments and sedimentation ponds would be minor, probably averaging less than 0.05 percent of total runoff from the study area. Consumptive use of water as a result of development of additional federal coal at high-level is expected to reduce total water yield from the study area by about 0.03 percent by 1980, increasing to about 0.5 percent by 1985, and 1.6 percent by 1990 (Table 8-48). The small reduction in total runoff as a result of cumulative development at high-level should have no significant impact on the study area, which normally produces runoff far in excess of water needs. Local water rights are protected by regulations (Chapter 2, Water Resources). Any reduction in flow downstream into the Colorado River system, however, would reduce the amount of water available to the water-deficient Lower Basin States and must be regarded as a significant impact to these states.

Estimated sediment yields as a result of mining and associated activities at cumulative high-level development are listed in Tables 8-50, 8-51, and 8-52. Results indicate that sediment yield due to development of additional federal coal at high-level from all disturbed areas would be larger than low-level by about 83 percent during 1978-80, about 146 percent during 1981-85, and about 470 percent during 1986-90. At cumulative high-level development, the net increase in sediment yield due to additional development of federal coal for 1978-90 would be about 37,700 tons. If all this sediment were to enter the river net and move downstream, which is highly unlikely, the sediment load in the Yampa River would increase about 1.0 percent. This change would not be measurable by standard sampling methods and should have no effect on aquatic biology or consumptive uses of water. Any increases in sedimentation in impoundments on the Colorado River would reduce their useful life minimally and should be a minor impact.

TABLE 8-50

ESTIMATED SEDIMENT YIELD AS A RESULT OF MINING AND ASSOCIATED ACTIVITIES AT CUMULATIVE HIGH-LEVEL DEVELOPMENT 1978-80

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines	3,280	770	27	- 743
Surface mine facilities and related R/W 1/	700	160	6	- 154
Underground mines and related R/W 1/	620	150	5	- 145
Power lines	1,880	440	700	+ 260
Power plants	0	0	0	0
Roads	630	150	950	+ 800
Railroads	490	110	1,030	+ 920
Population related disturbances	510	120	1,530	+1,410
Total	8,110	1,900	4,248	+2,348
Net change from low-level development (-) decrease (+) increase	+1,820	+ 430	+1,933	+1,503

1/ R/W, rights-of-way.

TABLE 8-51

ESTIMATED SEDIMENT YIELD AS A RESULT OF MINING AND ASSOCIATED ACTIVITIES AT CUMULATIVE HIGH-LEVEL DEVELOPMENT 1981-85

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines, new	8,430	3,290	69	-3,221
Surface mines, existing	3,280	1,280	17	-1,263
Surface mine facilities, new	1,200	470	10	- 460
Surface mine facilities, existing	700	270	4	- 266
Underground mines, new	900	350	7	- 343
Underground mines, existing	620	240	3	- 237
Power lines, new	0	0	0	0
Power lines, existing	1,880	730	940	+ 210
Power plants, new	380	150	950	+ 800
Power plants, existing	0	0	0	0
Roads, new	1,800	700	4,500	+3,800
Roads, existing	630	250	630	+ 380
Railroads, new	500	200	1,750	+1,550
Railroads, existing	490	190	240	+ 50
Population related disturbances, new	2,550	1,000	12,750	+11,750
Population related disturbances, existing	510	200	100	- 100
+12,650				
Net change from low-level development (-) decrease (+) increase	+10,125	+3,960	+13,027	+9,067

TABLE 8-52

ESTIMATED SEDIMENT YIELD AS A RESULT OF MINING AND ASSOCIATED ACTIVITIES AT CUMULATIVE HIGH-LEVEL DEVELOPMENT 1986-90

Activity	Area disturbed (acres)	Sediment yield before disturbance (tons)	Sediment yield as a result of disturbance (tons)	Net change in sediment yield increase (+) or decrease (-) (tons)
Surface mines, new	13,490	5,270	110	-5,160
Surface mines, existing	11,710	4,570	160	-4,410
Surface mine facilities, new	0	0	0	0
Surface mine facilities, existing	1,900	740	26	- 714
Underground mines, new	100	40	1	- 39
Underground mines, existing	1,520	590	21	- 569
Power lines, new	1,500	590	940	+ 350
Power lines, existing	1,880	730	940	+ 210
Power plants, new	1,000	390	2,500	+2,110
Power plants, existing	380	150	380	+ 230
Roads, new	2,600	1,020	6,500	+5,480
Roads, existing	2,430	950	2,430	+1,480
Railroads, new	1,000	390	3,500	+3,110
Railroads, existing	990	390	500	+ 110
Population related disturbances, new	1,800	700	9,000	+8,300
Population related disturbances, existing	3,060	1,200	600	- 600
Total	45,360	17,720	27,608	+9,888
Net change from low-level development (-) decrease (+) increase	+26,000	+10,160	+22,781	+12,621

High-level includes impacts caused by continued development of all existing coal activities (federal and non-federal) in the study area. It also includes all development of towns and other activities that could occur as a result of high-level coal development.

Emissions of total suspended particulates (TSP), sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), and non-methane hydrocarbons (NMHC) from mines, towns, and highways were determined using the assumption and methods of Chapter 4, Air Quality. Emissions from major point sources modeled for high-level were obtained from the same data sources as appear in Chapter 4.

Particulate emissions from mining of coal in the study area at high-level are indicated in Table 8-53.

Major point sources modeled for high-level include those sources listed for mid-level plus the Rangley Power Plant, Units 1-4 (Table 8-54). Emissions of the different pollutants are shown in the respective tables.

Emissions from the towns at high-level are shown in Table 8-55.

Region-wide emissions for the roads modeled for high-level are shown in Table 8-56. The road segments modeled for high-level are the same segments used for mid-level, shown on Map 4-1.

Emissions from railroads serving coal mines in the study area were not quantified or modeled because such emissions would be intermittent and impacts would be expected to be site-specific. Fugitive dust emissions from the construction of additional lines should be small and have no significant effect on regional TSP concentrations.

Oil shale tracts C-a and C-b are in the White River Valley dispersion sub-area. Emissions from these major sources would not interact with emissions from coal-related developments in the study area and therefore were not included in the air quality modeling.

There are no proposals for uranium mining, development of oil shale or geothermal resources in the study area before 1990 so consideration of them is not included in the air quality modeling.

Resultant Air Quality and Climate

Air quality impacts at high-level are discussed for additional development of federal coal and for cumulative development and associated regional growth for 1980, 1985, and 1990. Concentrations of pollutants for each case are compared to state and federal air quality standards and to established criteria for prevention of significant deterioration (PSD) of air quality.

TABLE 8-53

PARTICULATE EMISSIONS FROM MINING OF COAL IN THE STUDY AREA FOR HIGH-LEVEL (TONS/YEAR)

	1980	1985	1990
All mining	16,819	24,452	27,488
Additional development of federal coal	3,498	12,203	17,358

TABLE 8-54

EMISSIONS FROM THE RANGELY POWER PLANT (TONS/YEAR)

Source	Pollutant	Emissions 1980	1985	1990
Unit #1	Particulates	-	-	1,039
	SO_2	-	-	4,157
	NO_x	-	-	7,275
	CO	-	-	435
Unit #2	Particulates	-	-	1,039
	SO_2	-	-	4,157
	NO_x	-	-	7,275
	CO	-	-	437
Unit #3	Particulates	-	-	1,039
	SO_2	-	-	4,157
	NO_x	-	-	7,275
	CO	-	-	437
Unit #4	Particulates	-	-	1,039
	SO_2	-	-	4,157
	NO_x	-	-	7,275
	CO	-	-	437

TABLE 8-55

POLLUTANT EMISSIONS FROM TOWNS IN THE STUDY AREA
FOR CUMULATIVE DEVELOPMENT AT HIGH-LEVEL (TONS/YEAR)

Town	Pollutant	1980	1985	1990
Craig	PM	40	95	144
	NO_x	319	750	1,141
	CO	2,707	6,347	9,686
	NMHC	518	1,215	1,855
Steamboat Springs	PM	50	91	123
	NO_x	361	656	886
	CO	2,009	3,669	4,958
	NMHC	471	860	1,162
Meeker	PM	70	144	179
	NO_x	459	946	1,168
	CO	2,478	5,114	6,312
	NMHC	544	1,122	1,385
Rangely	PM	31	69	65
	NO_x	199	455	437
	CO	1,076	2,458	2,355
	NMHC	236	539	518
Hayden	PM	19	48	82
	NO_x	138	344	591
	CO	773	1,926	3,300
	NMHC	181	450	773
Oak Creek	PM	8	18	25
	NO_x	54	126	182
	CO	302	708	1,012
	NMHC	72	166	237

Additional Development of Federal Coal

Air quality impacts analyzed in this section are the result of emissions from additional development of federal coal and from growth of other sources of air pollution induced by this development. These concentrations do not include baseline levels or contributions from other activities.

The regional impact on annual TSP concentrations in the study area would extend over much of the area, particularly by 1990. Maps 8-8 through 8-10 show where predicted TSP increases would occur. A large portion of the study area would experience an increase of 1 ug/m^3 or more by 1990.

TABLE 8-56

VEHICULAR EMISSIONS FOR ROADS IN THE STUDY AREA
FOR CUMULATIVE DEVELOPMENT AT HIGH-LEVEL (TONS/YEAR)

	PM	NO_X	CO	NMHC
1980	3,718	2,508	28,523	3,044
1985	4,229	2,323	16,688	1,407
1990	5,155	2,538	10,393	794

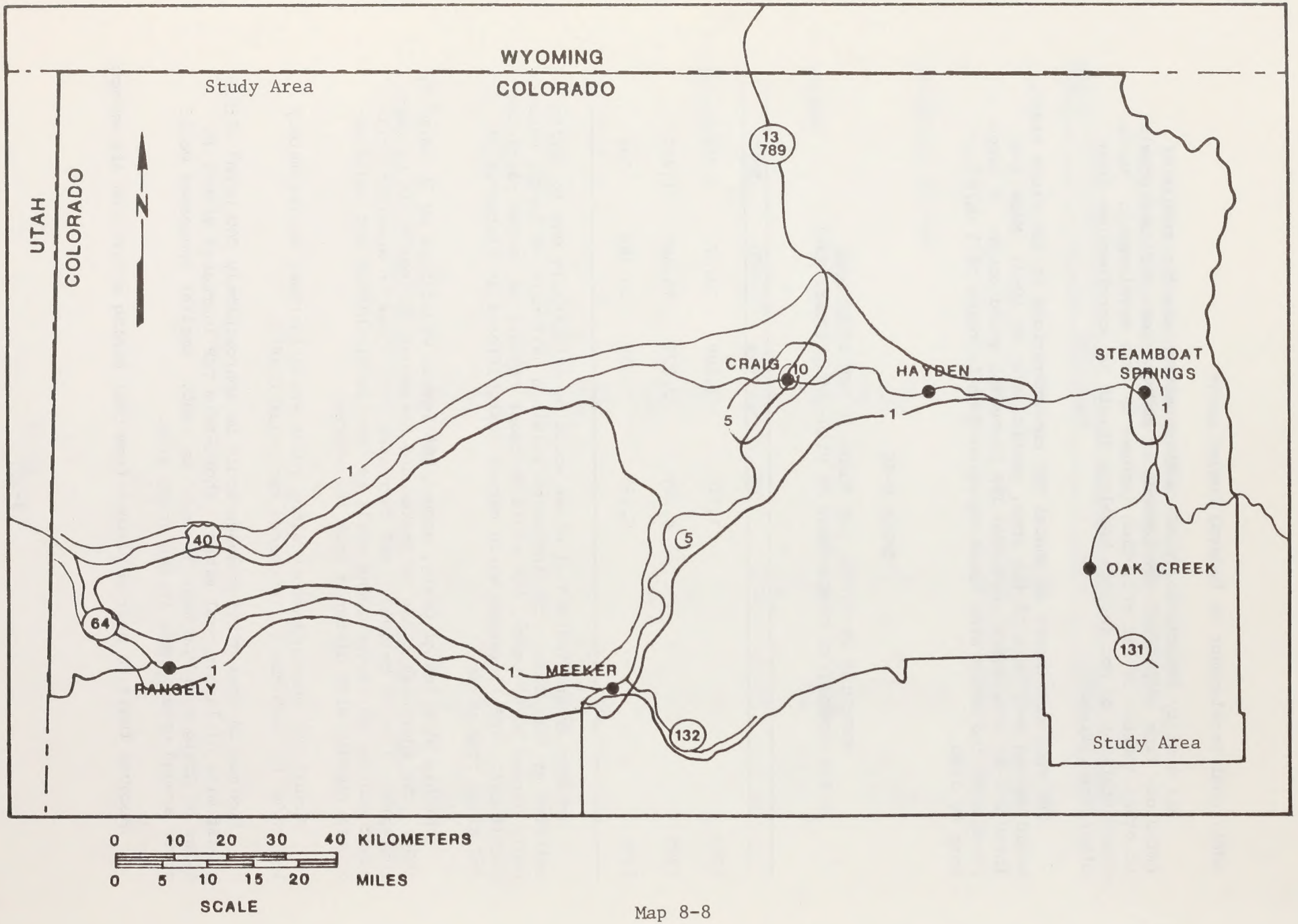
Impacts around individual mines would be principally due to mining activity at that site. TSP increases within a half mile of larger mines could exceed 50-60 ug/m^3, but would decrease rapidly as larger particles settle out. TSP increases would become insignificant at distances of 3-4 miles from mines.

Within 4½ miles of Craig, annual TSP levels would rise by 10 ug/m^3 by 1990. TSP increases close to Meeker and Steamboat Springs would be approximately 5 ug/m^3 by 1990. TSP increases very close to specific pollutant sources in larger towns would be considerbly higher but would decrease rapidly with distance from the source.

Annual TSP concentrations along roads would increase approximately 1-5 ug/m^3 by 1985 due to increased vehicular traffic.

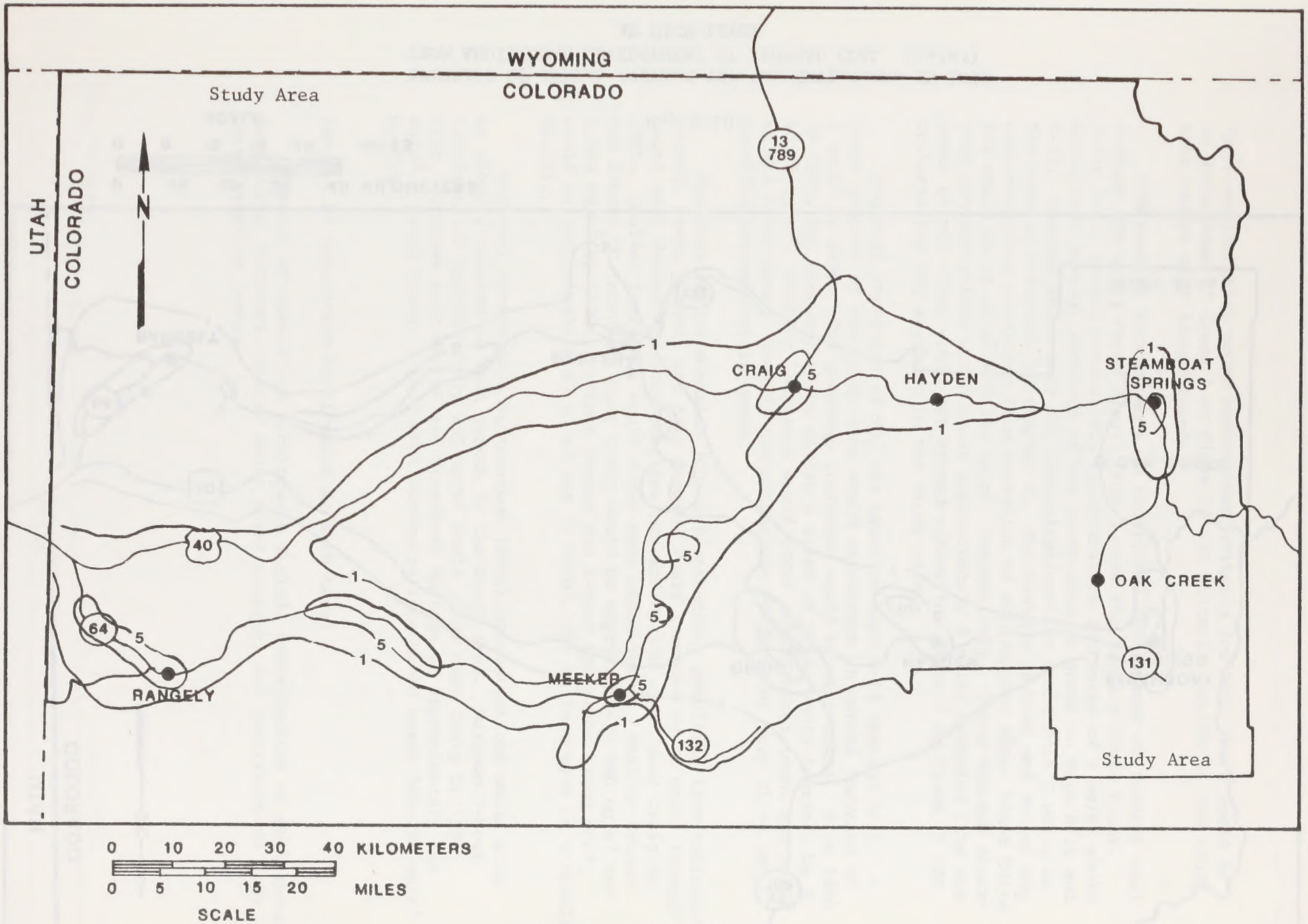
Maximum 24-hour TSP increases would be approximately 200 ug/m^3 within a half mile of larger coal mines. Short-term TSP increases within 4½ miles of Craig would be near 35 ug/m^3 by 1990. Smaller increases would occur around other towns in the study area.

Because fugitive dust emissions from coal mining activities are exempt



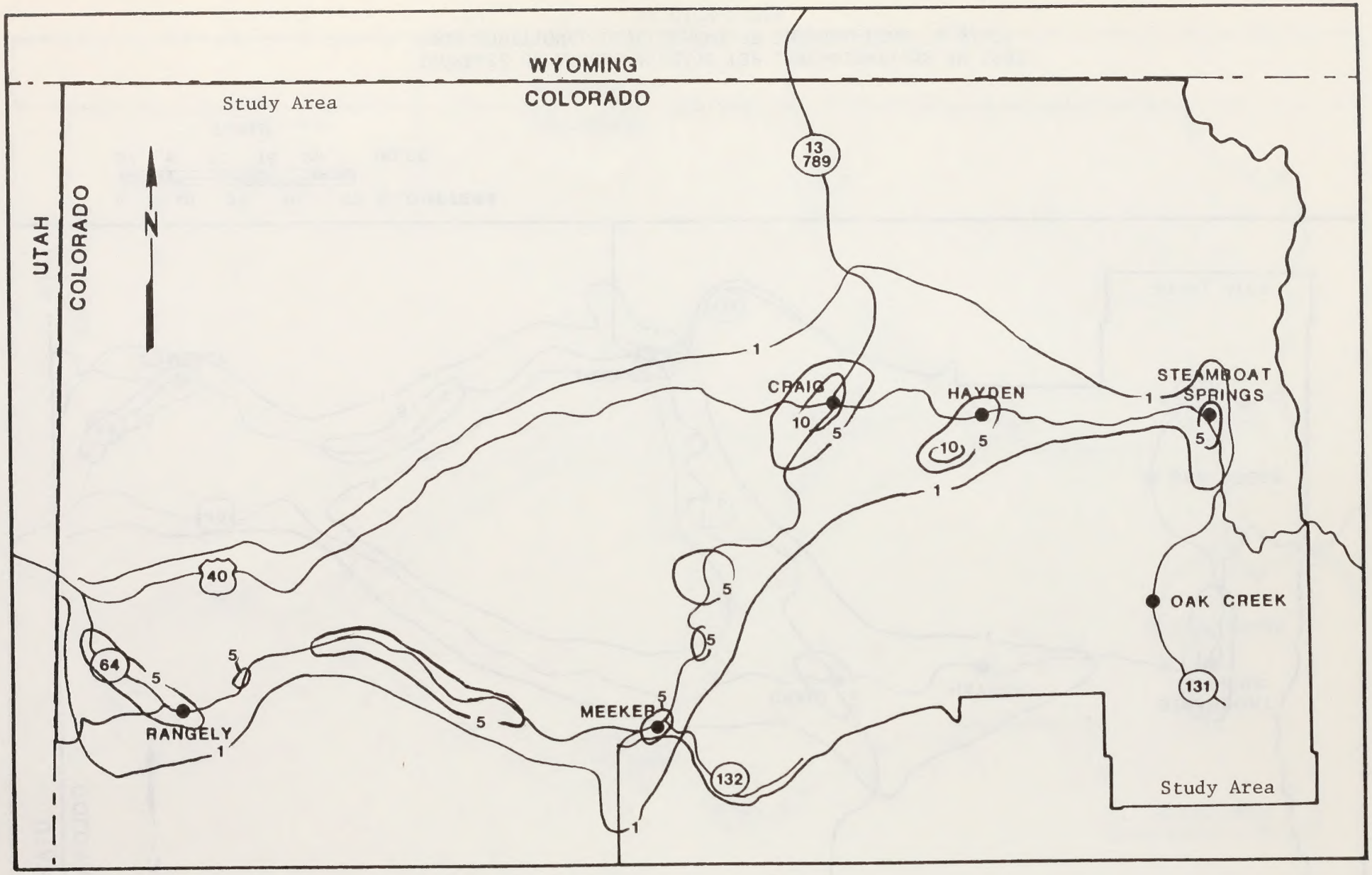
Map 8-8

INCREASE OF ANNUAL AVERAGE TSP CONCENTRATIONS IN 1980
FROM ADDITIONAL DEVELOPMENT OF FEDERAL COAL ($\mu g/m^3$)



Map 8-9

INCREASE OF ANNUAL AVERAGE TSP CONCENTRATIONS IN 1985
FROM ADDITIONAL DEVELOPMENT OF FEDERAL COAL ($\mu g/m^3$)
AT HIGH-LEVEL



Map 8-10

INCREASE OF ANNUAL AVERAGE TSP CONCENTRATIONS IN 1990
FROM ADDITIONAL DEVELOPMENT OF FEDERAL COAL ($\mu g/m^3$)
AT HIGH-LEVEL

from consideration under established criteria for PSD, there would be no violations of Class I or Class II PSD criteria for TSP in the study area except near larger towns.

SO_2 sources attributable to additional development of federal coal include the Craig Power Plant, Unit 3, and the Rangely Power Plant, Units 1-4. Annual average SO_2 concentration increases of 1 ug/m^3 would occur over several sections of the study area as shown on Maps 8-11 and 8-12. Maximum short-term SO_2 concentrations for Craig Unit 3 would be the same as discussed in Chapter 4. The maximum 24-hour and 3-hour SO_2 concentrations resulting from operation of the Rangely Power Plant Units 1-4 would be 34 ug/m^3 and 262 ug/m^3, respectively. These maximum short-term concentrations would occur approximately 3 miles downwind from the power plant. They would not exceed either the Class I or Class II PSD criteria for SO_2 anywhere in the study area.

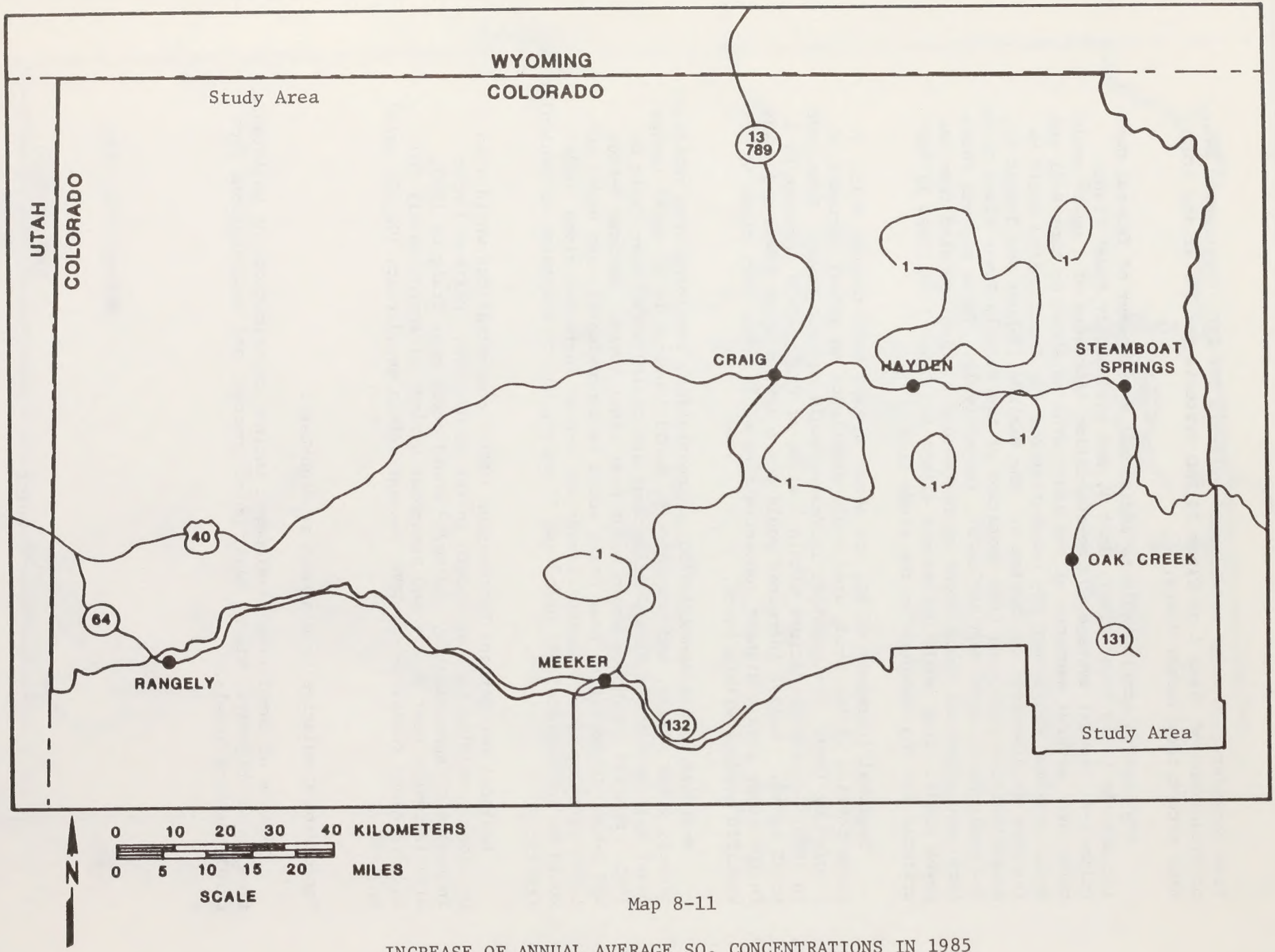
Regional increases of NO_2 are shown on Maps 8-13 through 8-15. A large portion of the study area would experience an annual increase of 1 ug/m^3 by 1990. The greatest increases would be near towns. From 1980 to 1990, NO_2 concentrations within 5 miles of Craig would increase by 5 to 15 ug/m^3. Smaller increases would occur around other towns and roads in the study area. Highest concentrations would occur very close to specific sources within towns.

Regional carbon monoxide (CO) concentration, resulting from vehicular travel, power plants, and town growth, would increase by 45 ug/m^3 (annual mean) near Meeker and Steamboat Springs and by 150 ug/m^3 near Craig by 1990. Smaller increases would occur near other towns. Maximum 8-hour and 1-hour CO increases near Craig would be approximately 660 ug/m^3 and 1,080 ug/m^3 by 1990. Maximun 8-hour and 1-hour increases along roads would be approximately 45 ug/m^3 and 75 ug/m^3, due to increases in vehicular traffic.

Regional non-methane hydrocarbon (NMHC) concentrations would also be closely related to town growth in the study area. Maximum 3-hour increases of approximately 240 ug/m^3 would occur near Craig by 1990, with increases near Meeker and Steamboat Springs of approximately 160 ug/m^3. Along roads, 3-hour NMHC concentrations would reach 100-150 ug/m^3 by 1990.

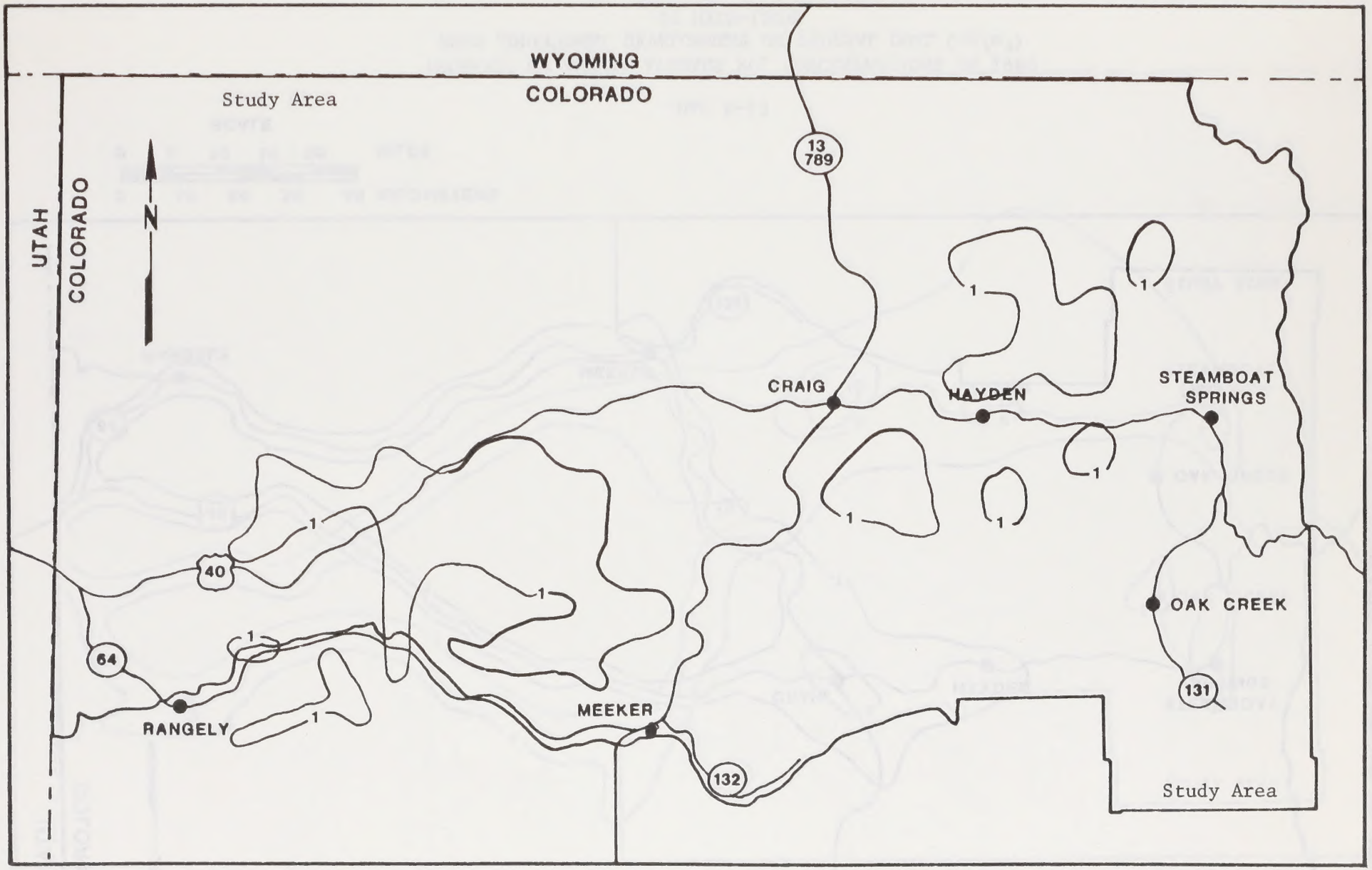
Impacts of Cumulative Development at High-Level

Impacts of cumulative development include contributions of pollutants from towns, highways, mines, major point sources, and contributions from rural baseline levels.



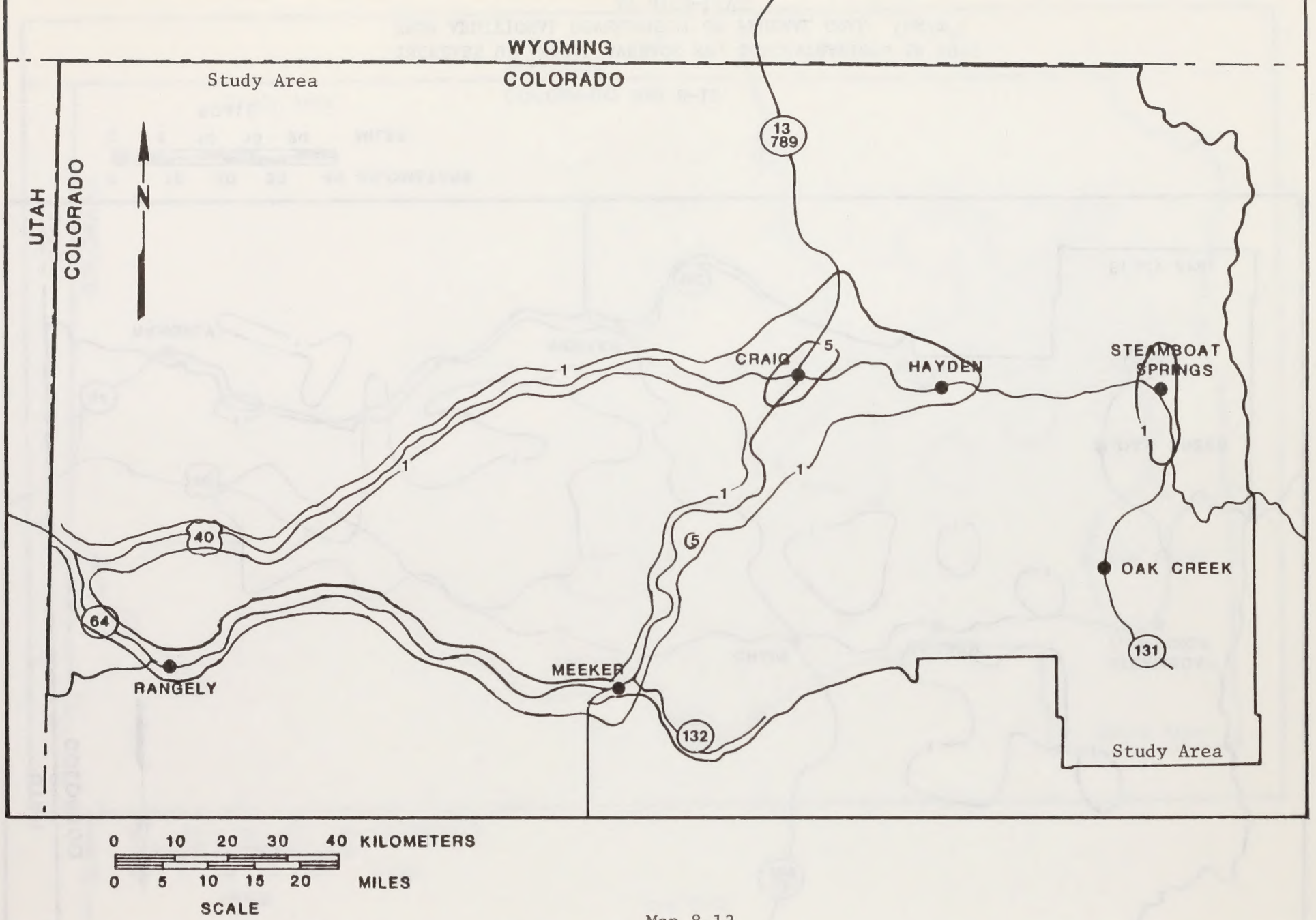
Map 8-11

INCREASE OF ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1985
FROM ADDITIONAL DEVELOPMENT OF FEDERAL COAL ($\mu g/m^3$)
AT HIGH-LEVEL



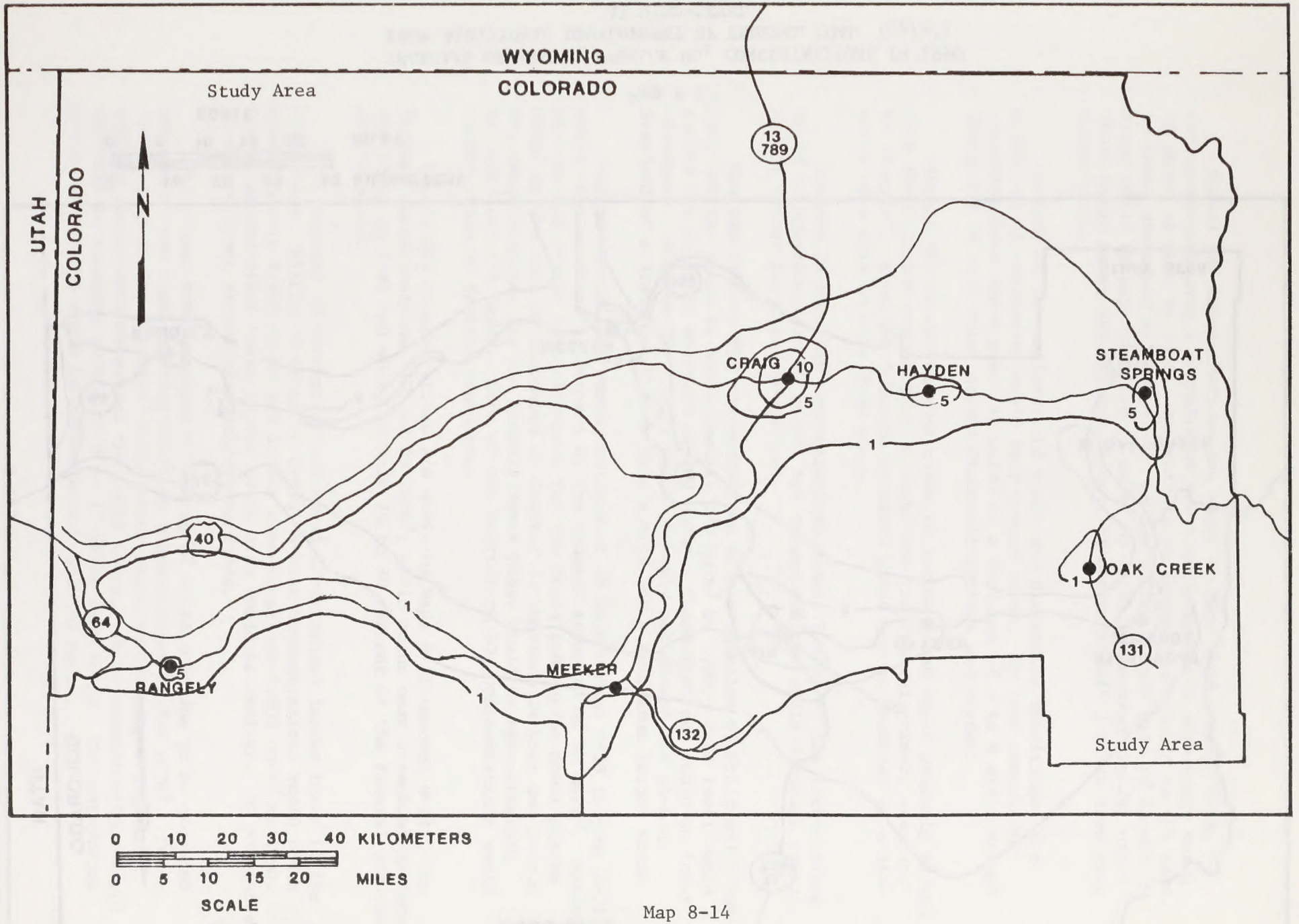
Map 8-12

INCREASE OF ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1990
FROM ADDITIONAL DEVELOPMENT OF FEDERAL COAL ($\mu g/m^3$)
AT HIGH-LEVEL



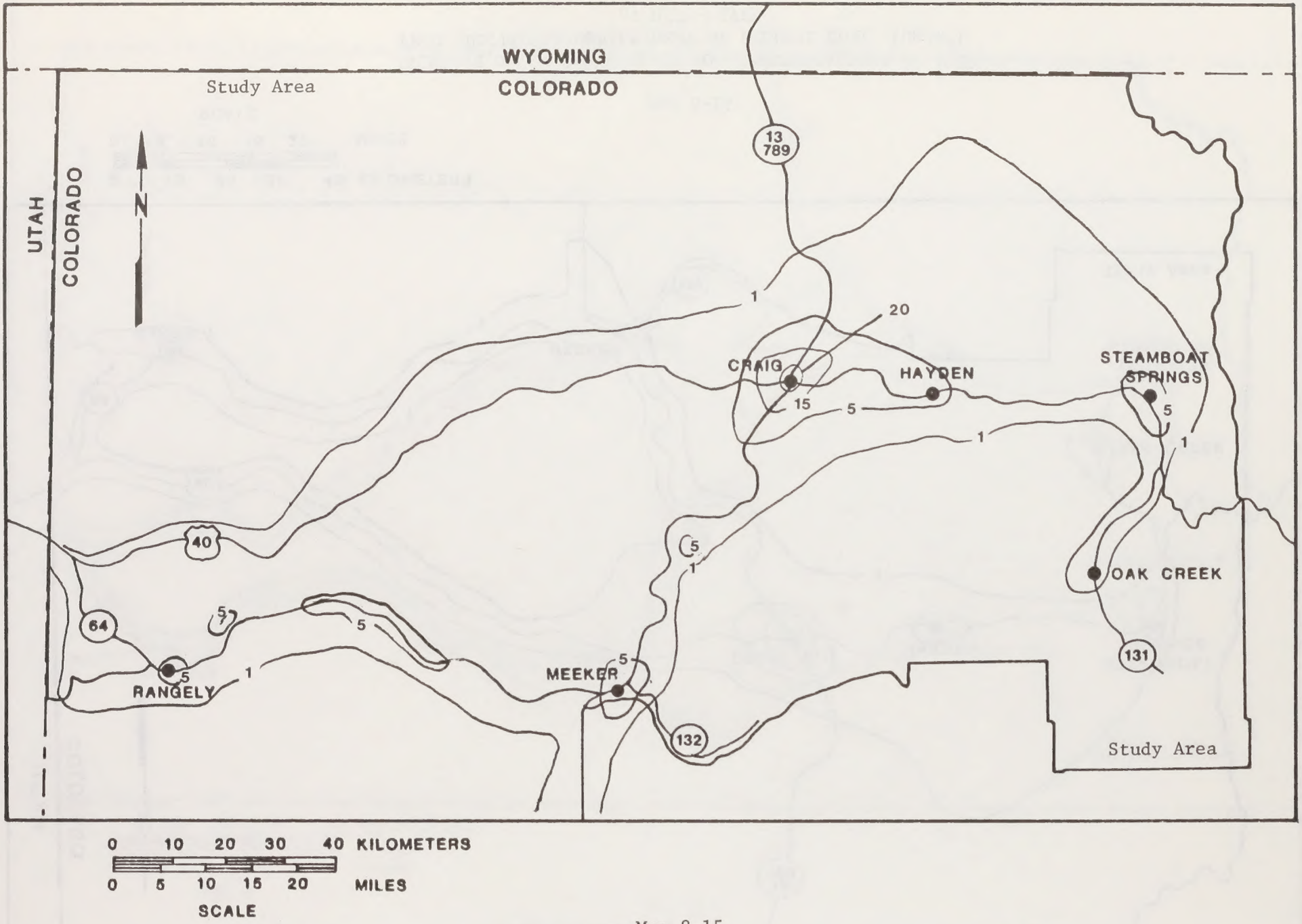
Map 8-13

INCREASE OF ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1980
FROM ADDITIONAL DEVELOPMENT OF FEDERAL COAL ($\mu g/m^3$)
AT HIGH-LEVEL



Map 8-14

INCREASE OF ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1985
FROM ADDITIONAL DEVELOPMENT OF FEDERAL COAL ($\mu g/m^3$)
AT HIGH-LEVEL



Map 8-15

INCREASE OF ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1990
FROM ADDITIONAL DEVELOPMENT OF FEDERAL COAL ($\mu g/m^3$)

Annual TSP concentrations are shown on Maps 8-16 through 8-18. Concentrations over a significant portion of the study area would reach 30 ug/m^3 or more by 1980. Concentrations around mines would be the same as those discussed in Chapter 4. Levels within a half mile of larger mines would be approximately 65 ug/m^3 by 1990, decreasing rapidly until there would be no significant impact, at approximately 3 miles from even larger mines.

Because of the influence of roads and dispersion conditions, distribution of pollutants would vary around towns. By 1990 annual TSP concentrations would reach 40 ug/m^3 at a distance of 2 to 8 miles around Craig and 1½ to 6 miles around Steamboat Springs and Hayden.

Annual TSP concentrations close to larger mines would probably exceed both the Colorado standard of 45 ug/m^3 and the federal primary standard of 75 ug/m^3. Even the Colorado standard would not be exceeded at a distance of a mile or more from mines.

Maximum 24-hour TSP concentrations within 1 mile of the larger mines would be approximately 70 ug/m^3, but concentrations would decrease rapidly as the larger particles settle out.

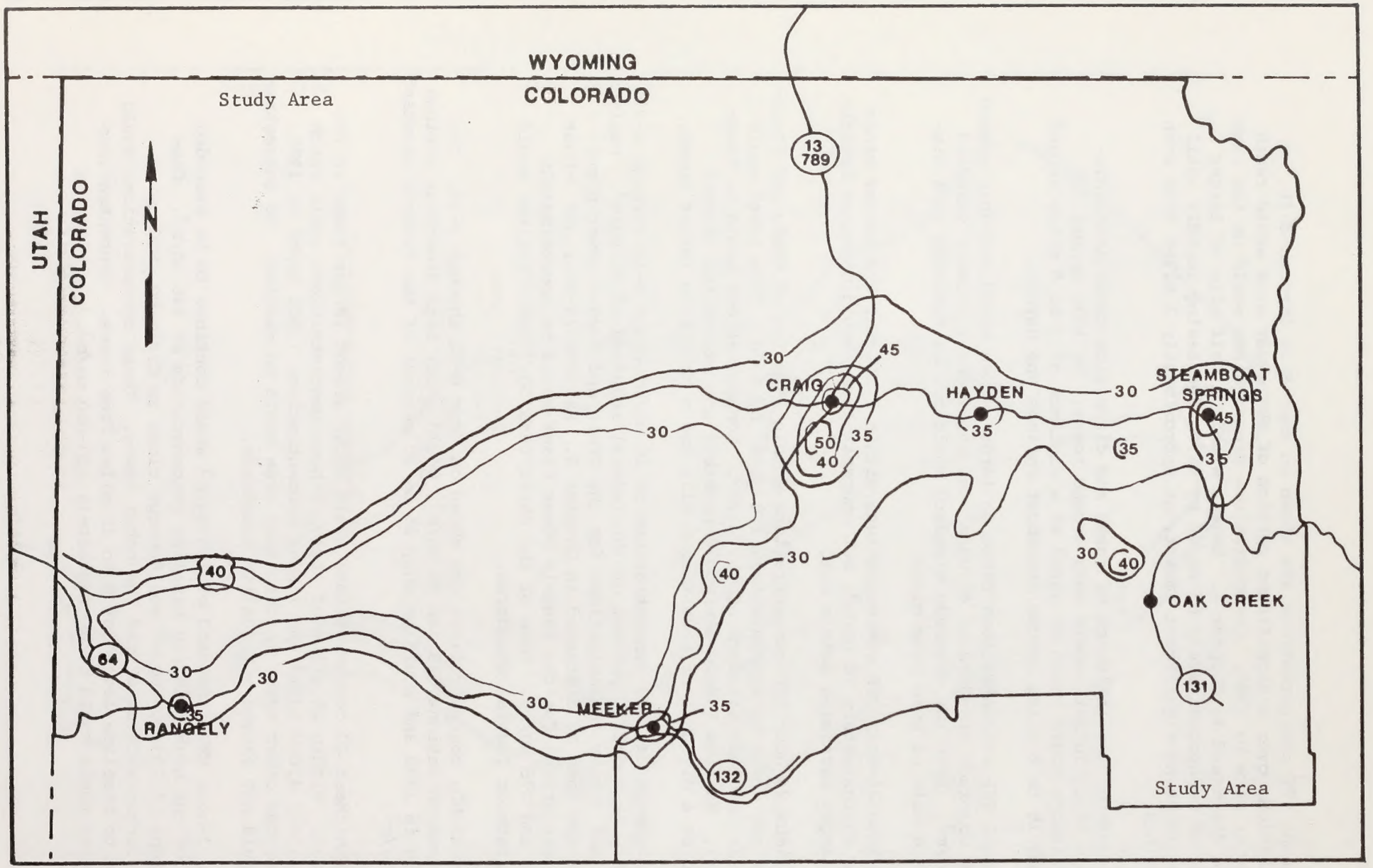
Maximum 24-hour TSP concentrations within 1½ miles of Craig and Steamboat Springs would be approximately 170 ug/m^3 by 1990. This level would exceed the Colorado standard of 160 ug/m^3. Concentrations would be lower elsewhere. Maximum TSP levels would probably not exceed the 24-hour standard at a distance of more than a mile and a half from larger towns.

Maximum annual SO_2 concentrations of 10 ug/m^3 (Maps 8-19 through 8-21) would only be about 12 percent of the federal standard of 80 ug/m^3. Maximum 24-hour and 3-hour concentrations for the Craig and Hayden power plants would be the same as discussed in Chapter 4. Maximum 24-hour and 3-hour SO_2 concentrations for the Rangely Power Plant would be approximately 40 ug/m^3 and 275 ug/m^3. None of the short-term SO_2 concentrations would exceed state or federal standards.

Annual NO_2 concentrations are shown on Maps 8-22 through 8-24. The highest concentrations, 25 and 30 ug/m^3, would occur near Steamboat Springs and Craig in 1990 and would be only 25 to 30 percent of the federal standard of 100 ug/m^3.

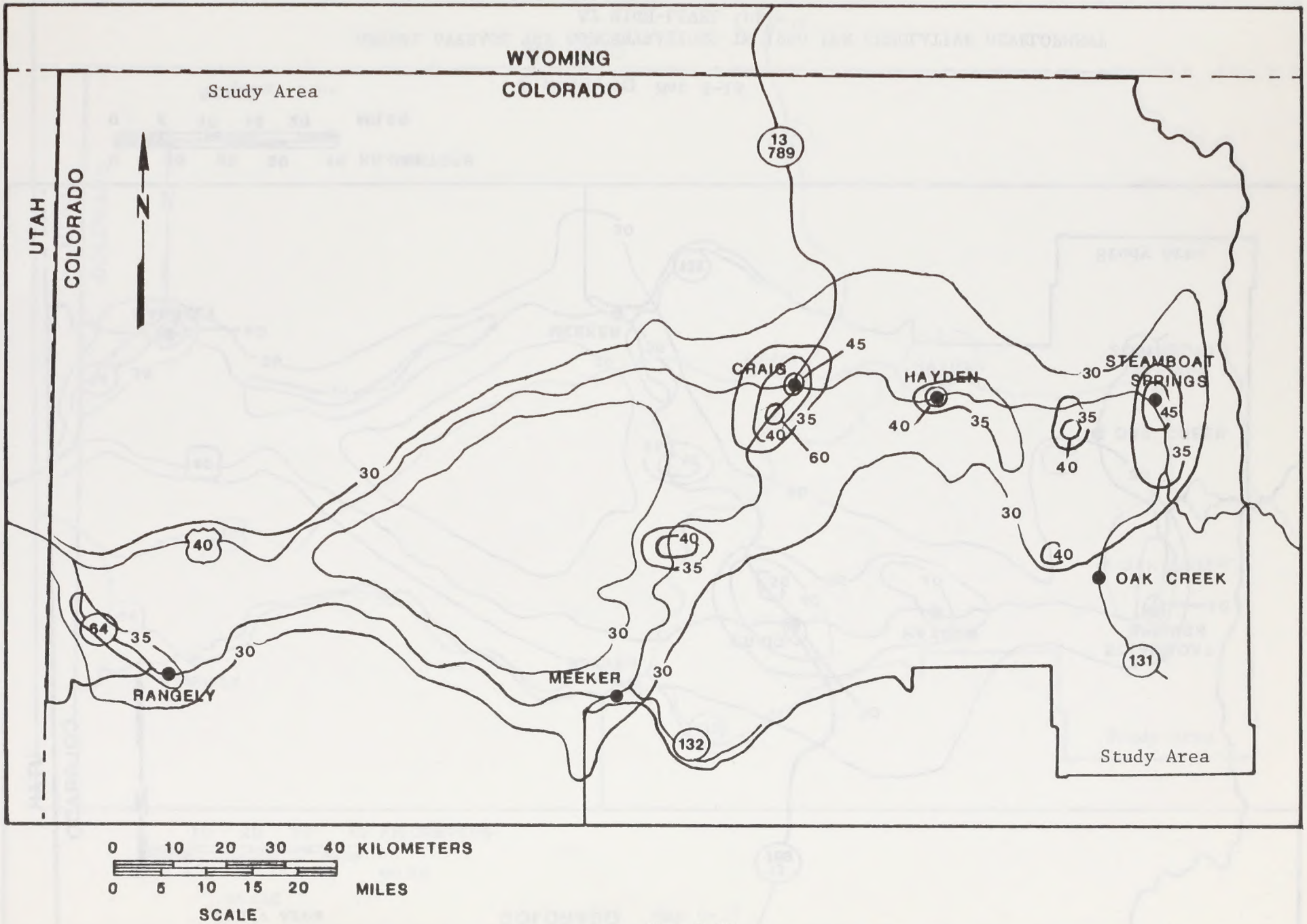
The highest CO concentrations would occur around larger towns in the study area. Within 1½ miles of Craig, 8-hour concentrations would reach approximately 4,800 ug/m^3 and 1-hour concentrations 7,800 ug/m^3 by 1990. Levels around other towns in the study area would be smaller. CO concentrations would not exceed air quality standards.

The 3-hour NMHC standard of 160 ug/m^3 would continue to be exceeded because of the high existing baseline concentration of 446 ug/m^3. Concentrations of 700-800 ug/m^3 would occur close to Craig by 1990, with similar concentrations around the other towns. These concentrations would decrease to baseline levels at 8 to 10 miles from towns. Concentrations along major roads would be approximately 550-600 ug/m^3.



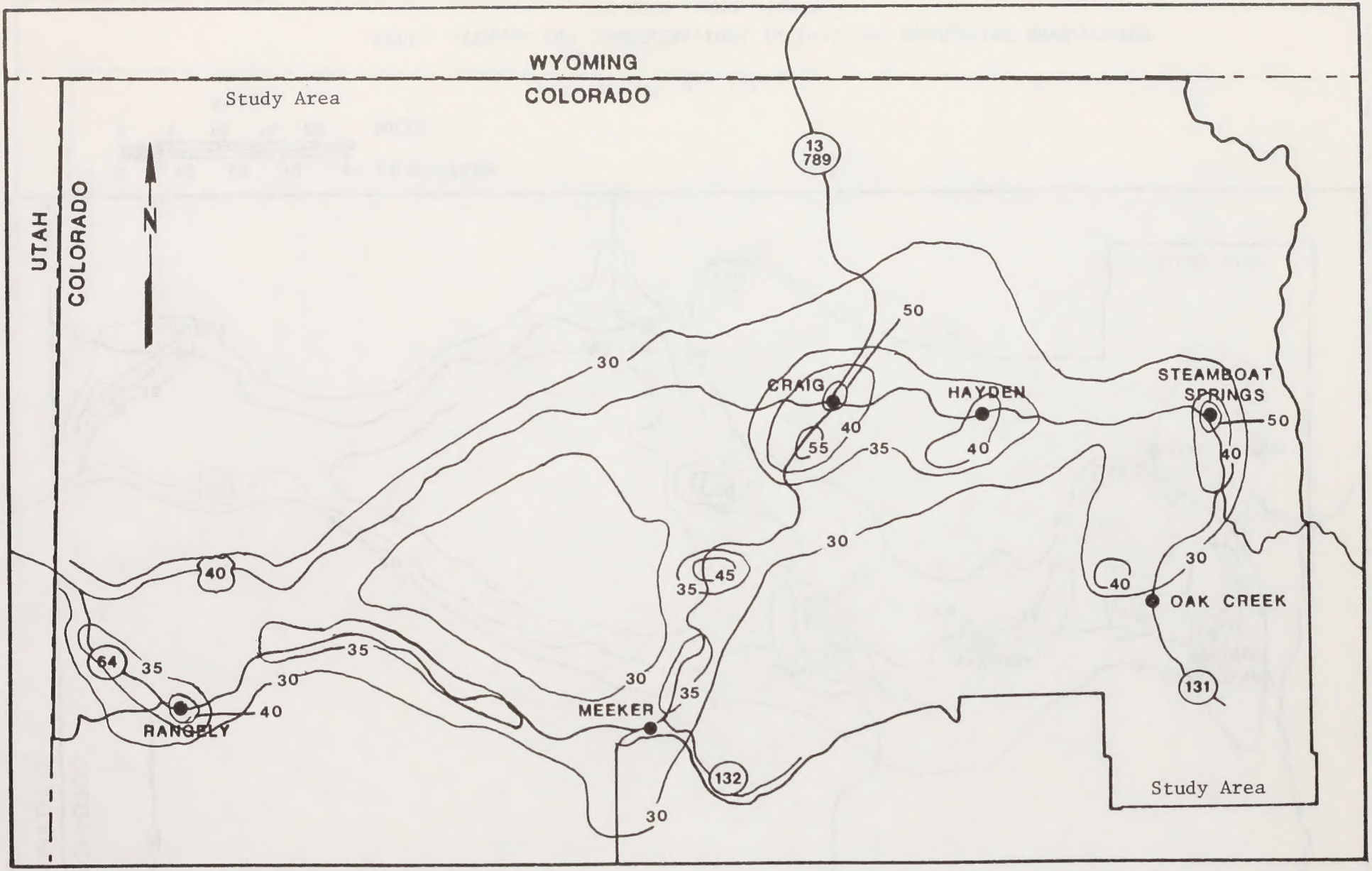
Map 8-16

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1980 FOR CUMULATIVE DEVELOPMENT



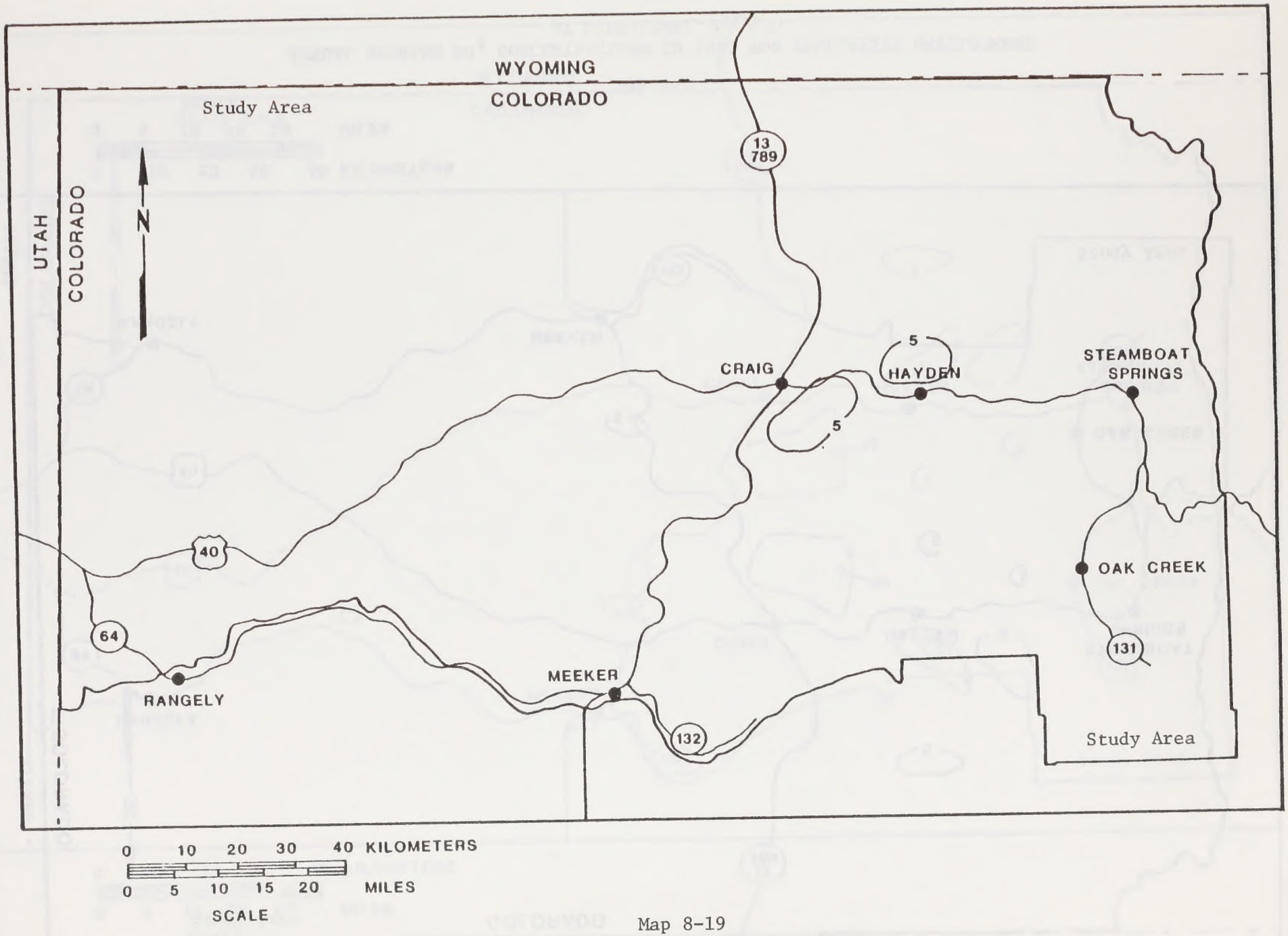
Map 8-17

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1985 FOR CUMULATIVE DEVELOPMENT AT HIGH-LEVEL ($\mu g/m^3$)



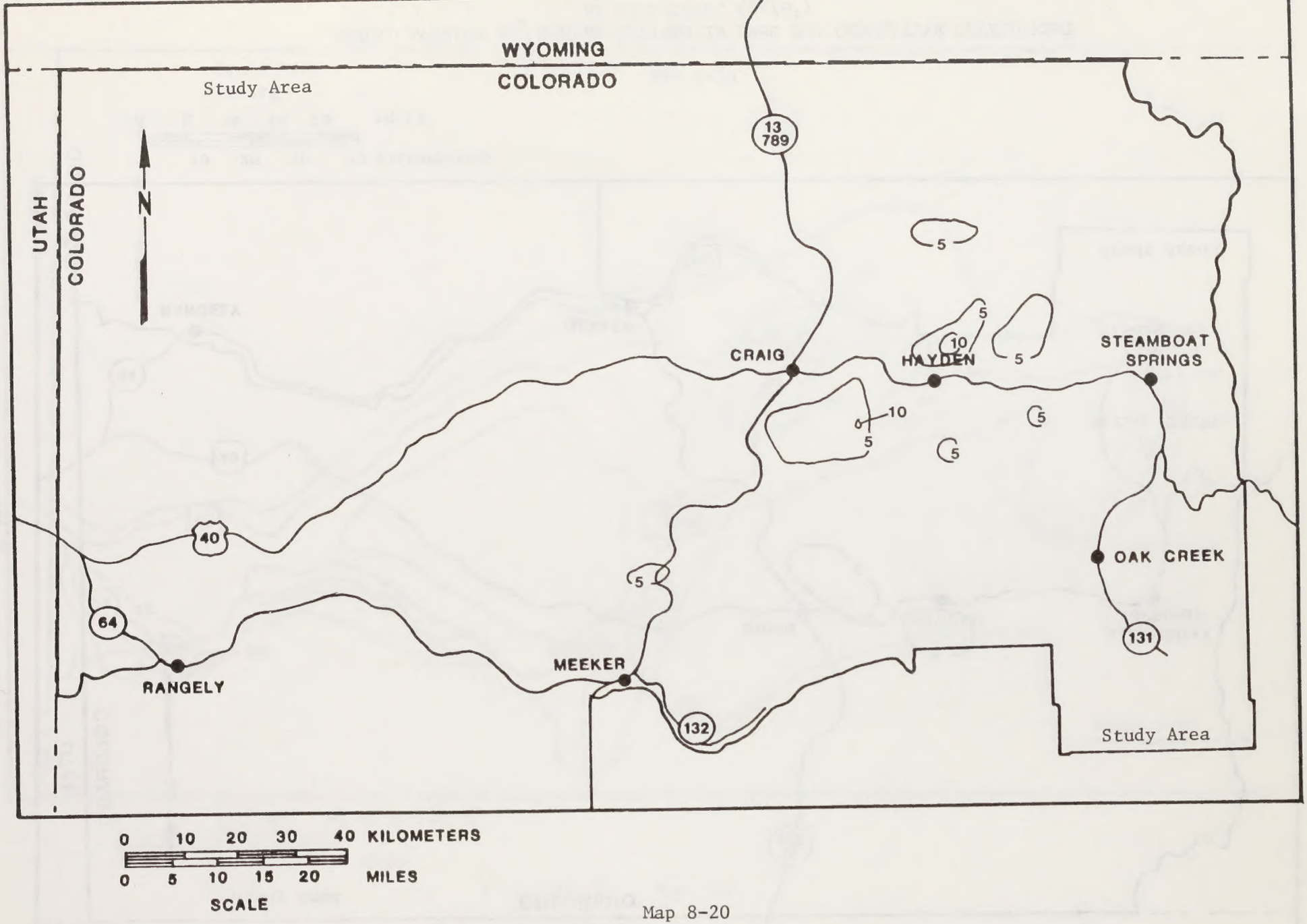
Map 8-18

ANNUAL AVERAGE TSP CONCENTRATIONS IN 1990 FOR CUMULATIVE DEVELOPMENT AT HIGH-LEVEL ($\mu g/m^3$)



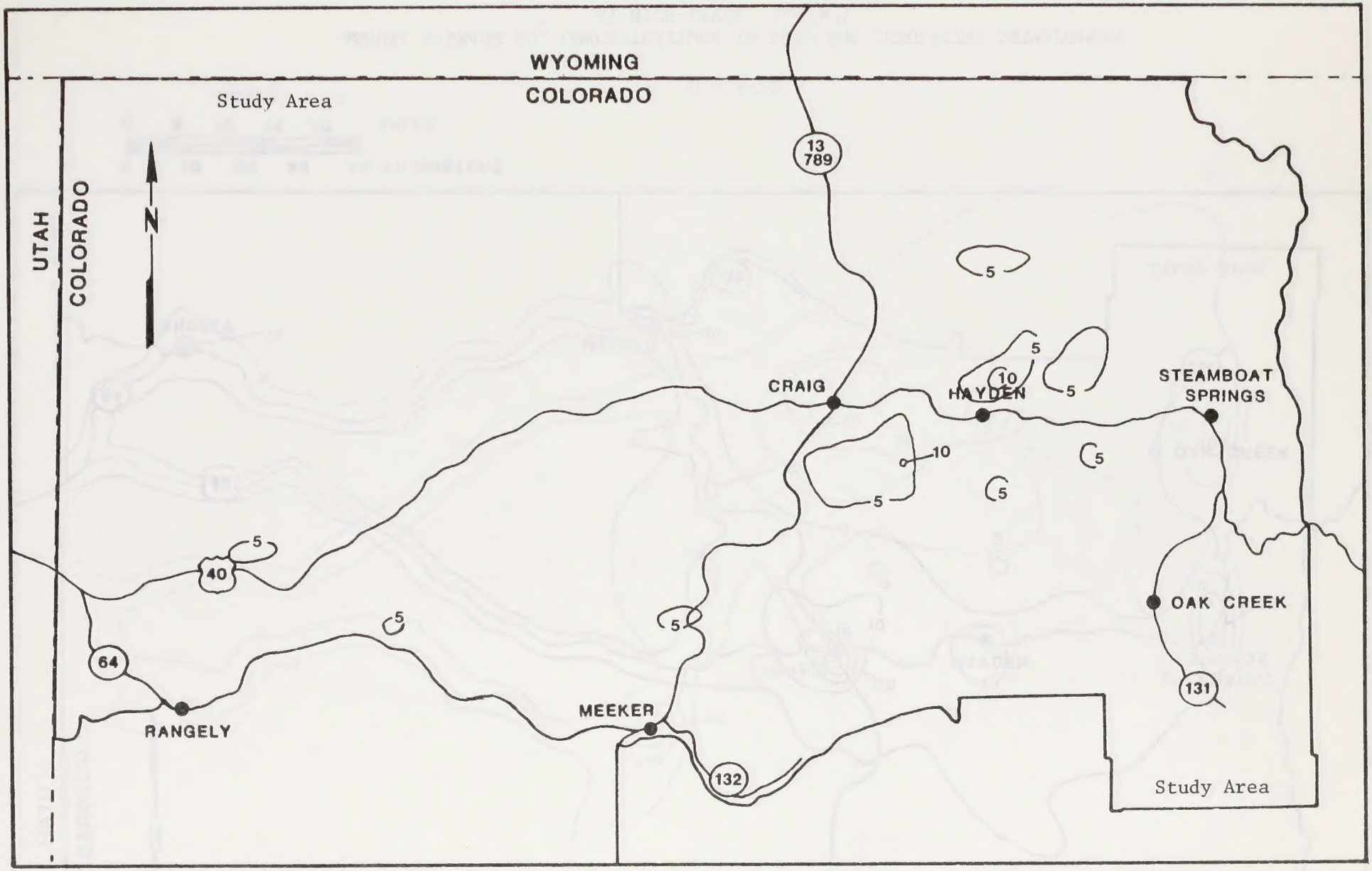
Map 8-19

ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1980 FOR CUMULATIVE DEVELOPMENT AT HIGH-LEVEL ($\mu g/m^3$)



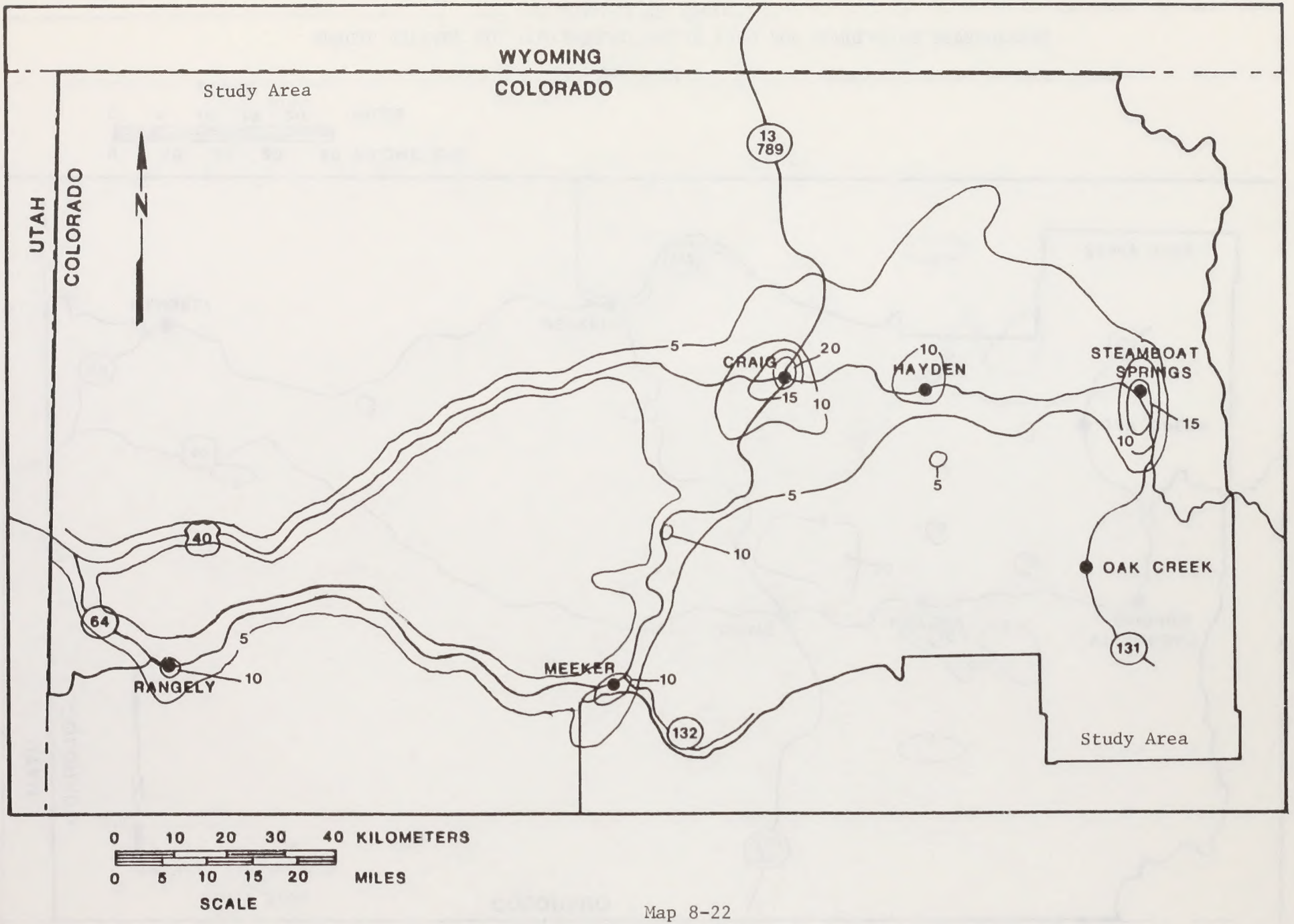
Map 8-20

ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1985 FOR CUMULATIVE DEVELOPMENT AT HIGH-LEVEL ($\mu g/m^3$)



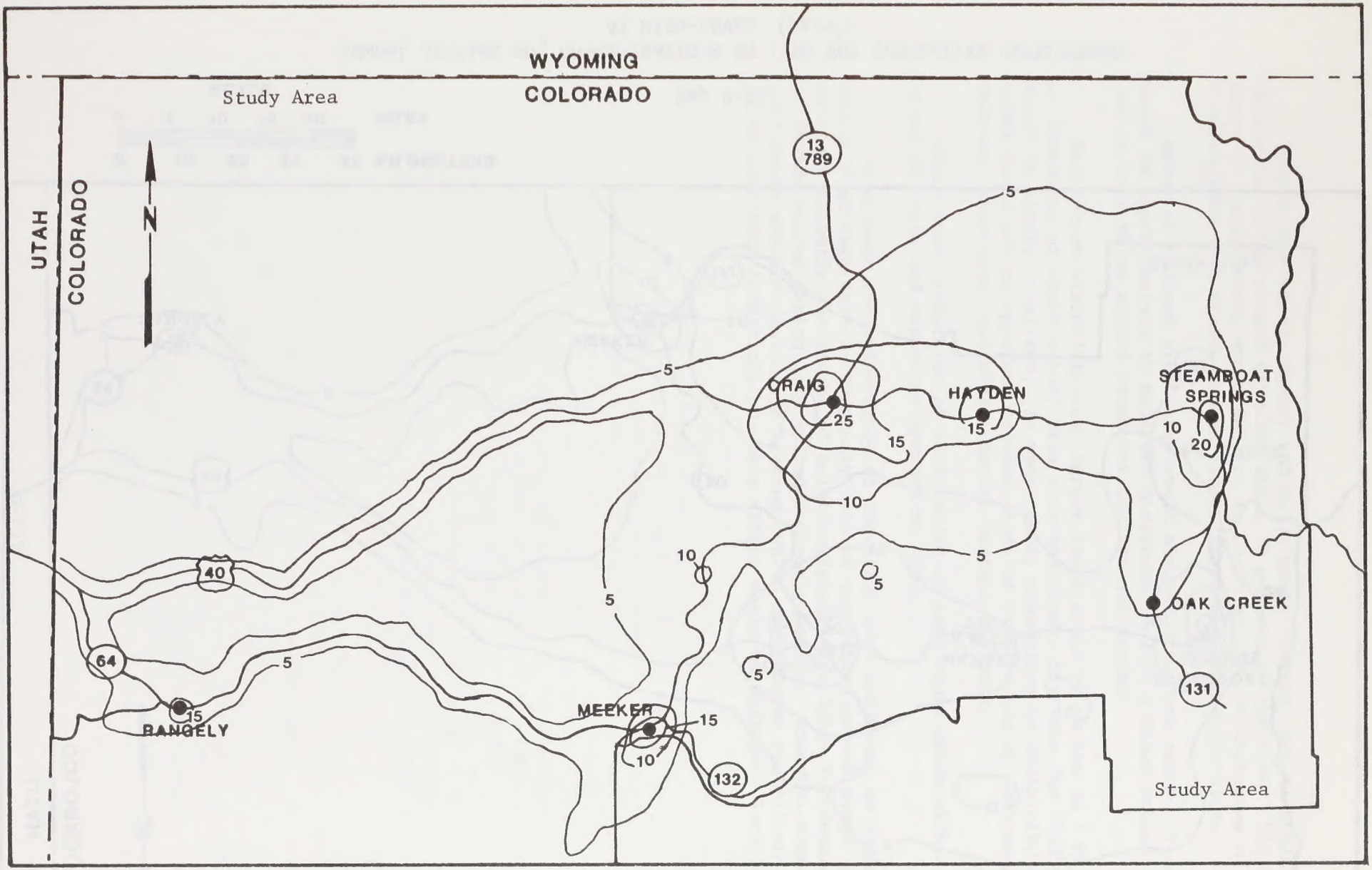
Map 8-21

ANNUAL AVERAGE SO_2 CONCENTRATIONS IN 1990 FOR CUMULATIVE DEVELOPMENT AT HIGH-LEVEL ($\mu g/m^3$)



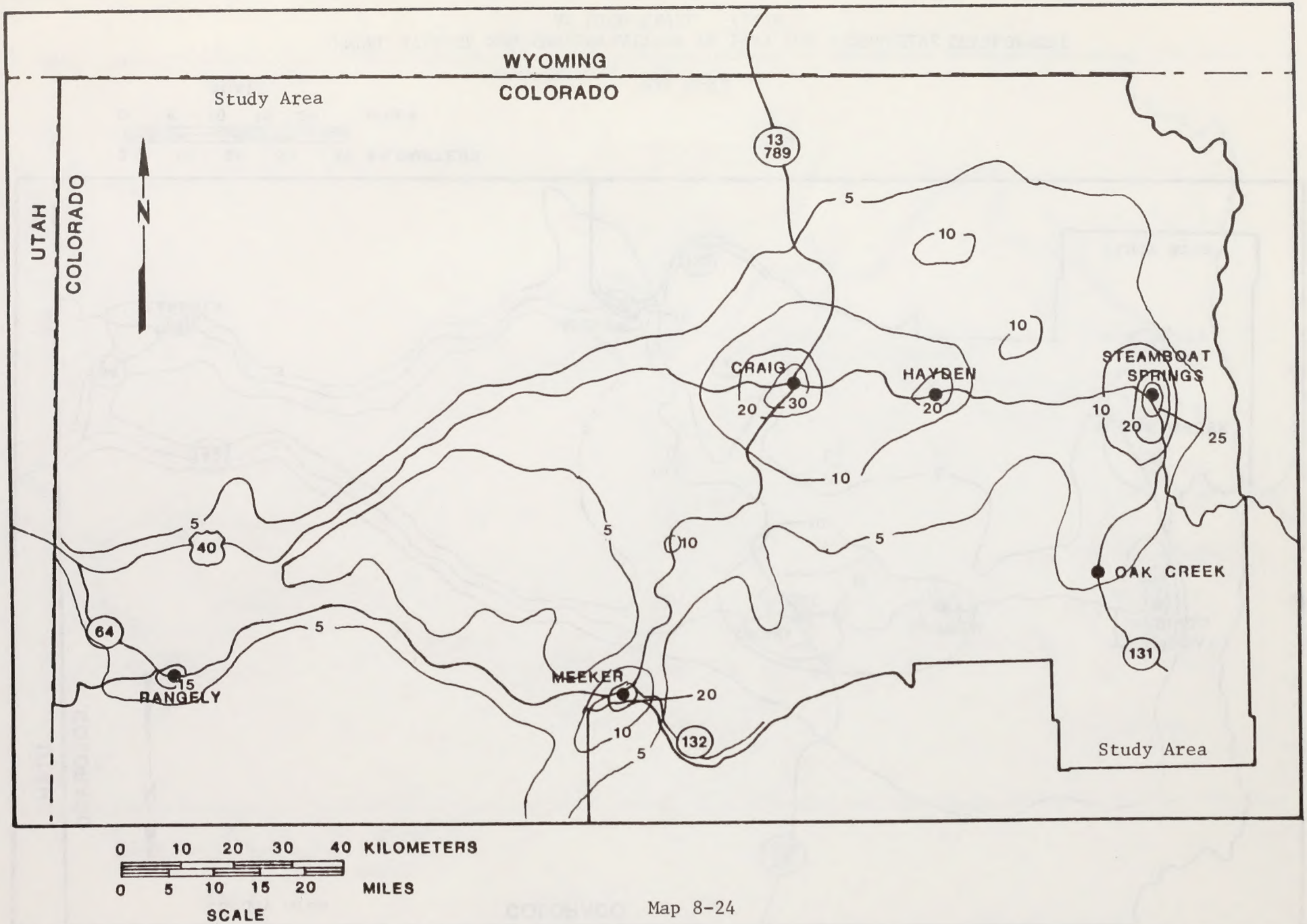
Map 8-22

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1980 FOR CUMULATIVE DEVELOPMENT AT HIGH-LEVEL ($\mu g/m^3$)



Map 8-23

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1985 FOR CUMULATIVE DEVELOPMENT AT HIGH-LEVEL ($\mu g/m^3$)



Map 8-24

ANNUAL AVERAGE NO_2 CONCENTRATIONS IN 1990 FOR CUMULATIVE DEVELOPMENT AT HIGH-LEVEL ($\mu g/m^3$)

Except near mines, towns, and major point sources, annual horizontal visibility would exceed 45 miles about 50 percent of the time. Visibility close to larger mines would decline to 20-25 miles. At distances of 1 to 2 miles from most mines, annual visibility would exceed 35 miles.

Areas of reduced visibility would also occur around towns. Visibility would be approximately 40 miles at distances of 2 to 8 miles around Craig and 1½ to 6 miles around Steamboat Springs and Hayden.

Short-term visibility near larger mines could be as low as 7 miles at distances of about a half mile from the mines, but this low visibility would be highly localized. In many cases, reductions in visibility around mines would not be apparent because lines of sight would be obstructed by canyons, mountains, and other complex terrain features.

Short-term visibility of 12-13 miles or less would occur within 1½ miles of Craig and Steamboat Springs by 1990.

The climate and meteorology of the study area would not be significantly affected at high-level. Temporary loss of vegetation around mines could decrease slightly the amount of moisture locally available for formation of thunderstorms during late spring and early summer. However, exposed soil would enhance convective heating, which contributes significantly to thunderstorm formation, but this effect would be extremely localized.

After mitigation by federal and state regulations, residual mining- and related-soil impacts would be of the same kind for high-level as for mid-level (Chapter 4, Impacts), however, surface disturbance and permanently removed acreage would be greater. There would be some permanent loss of soil productivity, loss of natural soil integrity, potential soil loss and mixing from unpredictable wind and water action, soil loss from increased recreation demands, and short-term reduction in soil productivity.

Surface disturbance from cumulative development at high-level would be 8,110 acres during 1978-80, 15,760 acres during 1981-85, and 21,490 acres during 1986-90, totaling 45,360 acres. Additional federal coal at high-level would disturb 1,820 acres during 1978-80, 8,305 acres during 1981-85, and 15,875 acres during 1986-90, totaling 26,000 acres.

Surface mining at high-level would disturb 3,280 acres during 1978-80, 8,430 acres during 1981-85, and 13,490 acres during 1986-90, totaling 25,200 acres. Additional federal coal at high-level would disturb 470 acres during 1978-80, 3,150 acres during 1981-85, and 8,660 acres during 1986-90, totaling 12,280 acres.

Permanent loss of soil productivity from ancillary development (mine facilities, power plants, railroads, and increased urbanization) at high-level would affect 2,950 acres during 1978-80, 7,330 acres during 1981-85, and 6,500 acres during 1986-90, totaling 16,780 acres. Of this, additional federal coal at high-level would account for 1,350 acres during 1978-80, 5,155 acres during 1981-85, and 5,715 acres during 1986-90, totaling 12,220 acres.

Loss of natural soil properties and creation of new soil complexes would be unavoidable on all areas disturbed. The nature of changes are described in this chapter, Low-Level, Soils and in Chapter 4, Soils. Soil loss and mixing by wind and water from new housing developments and other urbanization would be unmitigated, totaling 4,860 acres for cumulative development and 3,450 acres for additional federal coal at high-level by 1990. The amount of soil loss and loss of soil productivity cannot be predicted.

Increases in off-road vehicle use (see Recreation) due to population growth would result in localized compacting of soil and destruction of vegetation, but these effects are not quantifiable for the study area.

Short-term reduction of soil productivity would result from surface mining and powerline construction until those areas would be restored and capable of supporting vegetation consistant with previous land use (see Vegetation). Short-term reduction in soil productivity at high-level would affect 5,160 acres during 1978-80, 8,430 acres during 1981-85, and 14,990 acres during 1986-90, totaling 28,580 acres. Of this, additional

federal coal at high-level would affect 470 acres during 1978-80, 3,150 acres during 1981-85, and 10,160 acres during 1986-90, totaling 13,780 acres.

All impacts discussed for high-level development would be unavoidable and adverse.

Soil disturbance would occur around areas of coal development (southwest Routt County, southeast Moffat County, the area north of Rangely, and the area northeast of Meeker) and areas of population growth such as Meeker, Craig, Hayden, and Steamboat Springs. Soils affected in the study area are indicated on Map 1-3 (Appendix C), location of mines for high-level, and Foldout 8, Appendix B, NWCCRES, General Soil Map. Soil association descriptions including their characteristics and reclamation potentials appear in Table 2-21. The soil associations expected to be affected at high-level coal development are #59, #62, #21, and #35. The characteristics of these associations pertinent to impacts in the study area are described in Chapter 4, Soils.

In a portion of the coal development area covered by soil association #59, which is a good source of topsoil, steep slopes occur, prohibiting topsoil removal or requiring slope stabilizing techniques such as mulching if the landscape is returned to the original steep topography. Soil erosion would be the direct result of excessive slopes.

The finer clay fraction of soil association #21, an Aridisol, and #62, a Mollisol, could present erosion problems during topsoil removal, storage, and redistribution. Clayey textures are highly susceptible to water and wind erosion. To avoid excessive erosion, the amount of exposed bare soil during revegetation and topsoil removal must be limited as well as establishing a quick, protective, vegetative cover on stockpiles and replaced topsoil. Clayey soils are also easily compacted by heavy equipment, decreasing their ability to hold soil moisture and thereby diminishing the amount available to plants. Overall, soil associations #21 and #62 have a good potential for reclamation, providing all precautions are taken to overcome undesirable effects of clayey textures.

Soil association #35, an Entisol, has a good potential for reclamation, except for its limited capacity to retain moisture during June and July. During this period, retention of moisture by soils is important to survival of vegetation.

Overall the reclamation potential in the study area is good, but due to the broad soil mapping units, mines could easily be developed on inclusions rather than on the major soil components of the study area. To actually quantify impacts in any specific coal development area, a detailed soil survey, as required by OSM regulations, is needed to complement a cumulative soil association analysis. This would be necessary to further identify soil types, distribution, physical and chemical characteristics, inclusions, and reclamation potentials. A detailed soil survey would provide the necessary premining guide for identifying undisturbed soil characteristics to aid in reclamation.

Development of coal resources at high-level would cause the temporary disturbance of 5,160 acres of vegetation by 1980, an additional 8,430 acres by 1985, and an additional 14,990 acres by 1990, totaling 28,580 acres. Of this acreage, development of additional federal coal would temporarily disturb 470 acres by 1980, an additional 3,150 acres by 1985, and an additional 10,160 acres by 1990, totaling 13,780 acres.

The process of revegetation of the above disturbed acreage would be expected to have begun on 200 acres by 1980, an additional 5,160 acres by 1985, and an additional 7,310 acres by 1990, totaling 12,670 acres by 1990. Of the acreage, revegetation is expected to have begun on 100 acres of additional federal coal lands by 1980, an additional 470 acres by 1985, and an additional 2,030 acres by 1990, totaling 2,600 by 1990.

Development of coal resources along with ancillary facilities and housing would cause the permanent loss of 2,950 acres of vegetation by 1980, an additional 7,330 acres by 1985, and an additional 6,500 acres by 1990 for a total of 16,780 acres. Development of additional federal coal would account for 1,350 acres of the permanent loss of vegetation by 1980, an additional 5,155 acres by 1985, and an additional 5,715 acres by 1990, totaling 12,220 acres. These acreages and types of vegetation disturbance can be found in Tables 8-42 and 8-43.

Disturbance to vegetation would be expected to involve the following vegetative types: sagebrush, 50 percent (1.03 percent of the total study area (northwest Colorado)); mountain shrub, 19 percent (1.31 percent of the study area); aspen, 9 percent (1.5 percent of the study area); creek bottom, 5 percent (10.05 percent of the study area); cropland, 11 percent (2.9 percent of the study area); pinyon-juniper, 9 percent (0.06 percent of the study area).

A direct result from the removal of vegetation would be loss of production for grazing livestock and wildlife (see Domestic Fauna). Each vegetative type is calculated as having a certain number of acres per animal unit month (AUM). The sagebrush type has 8 acres per AUM, mountain shrub type 6 acres per AUM, aspen woodlands type 3 acres per AUM, and creek bottom type 1 acre per AUM.

Loss of production for livestock and wildlife would mean fewer numbers of each in the areas of coal development which would be southwest Routt County, southeast Moffat County, the area north of Rangely, and the area northeast of Meeker in Rio Blanco County. This loss of production could be significant to livestock producers whose operations are affected. The significance to an individual operator would be proportional to the area of his operation lost (see Domestic Fauna). The impact of lost production to wildlife would not be significant compared to the total wildlife populations of the study area (see Wildlife).

Total removal of native vegetation from an area would result in additional impacts on the vegetative ecosystem, more fully described in Chapter 4, Vegetation. There would be loss of a diverse vegetation capable of withstanding climatic extremes and utilizing precipitation and sunlight throughout the growing season. There would also be a loss of the present vegetative successional stage. This simpler vegetation would be more susceptible to climatic extremes and diseases. Transplanting of trees and shrubs on a site could speed the establishment of a more diverse vegetative ecosystem.

Loss of soil productivity could affect the time needed to reestablish vegetative ecosystems which may take 20 to 50 years. Current reclamation practices have not been in use long enough to determine whether a significant number of native plant species can be established on reshaped topsoil spoils.

With the loss of vegetation on the site, the probability of increasing livestock and wildlife numbers on adjacent sites is high, with probable over utilization of adjacent sites. Reclamation could reestablish forage after 4 years, however (see Domestic Fauna).

Changes in ground water flows which may result from mining (see Water Resources) would effect vegetation. Increases near the surface would increase vigor and density of vegetation while a loss may have the opposite effect. Where this would cannot be predicted but it would be limited to the area of coal development and is not expected to be significant.

Changes in surface water flows would be limited to the area of coal development and are not expected to be significant to vegetation.

Threatened and Endangered Species

Vegetation has not been studied in sufficient depth to determine locations of threatened or endangered species within the study area.

Wildlife

Impacts from high-level coal development and ancillary activities would have adverse effects on wildlife habitat and species in the study area. All of the wildlife species in the area would be impacted from the permanent loss of habitat resulting from new roads, power plants, railroads, and construction of housing to accommodate population growth. There would be 2,950 acres of habitat permanently removed by 1980, 10,280 acres by 1985, and 16,780 acres by 1990. In addition to the permanently lost acreage, there would be a temporary disturbance of 5,160 acres by 1980, 13,590 acres by 1985, and 28,580 acres by 1990 from powerline construction and surface mining.

Portions of the area would be revegetated, but by 1990 none of the areas would be considered at carrying capacities comparable to existing wildlife habitat communities (see Chapter 4, Wildlife). Every species of terrestrial fauna in the study area, listed in Appendix D (NWCCRES), would be affected by loss of habitat. The degree of impact would depend on the adaptability of the species involved and their mobility. Because of a lack of species density and composition data for the majority of wildlife species it is impossible to adequately estimate the reduction in carrying capacity for most non-game species that would result from high-level coal development. Those species closely associated with sagebrush and mountain shrub habitat types would be the most severely impacted by coal development while species associated with grasslands would be adversely impacted during mining but beneficially impacted after revegetation (Appendix D, NWCCRES).

Permanently lost habitat would have the most significant impact on game species such as elk, mule deer, antelope, and sage grouse (Table 8-53). Most of the loss would accrue to the sagebrush, mountain shrub, and aspen habitat types, which constitute deer and elk winter range. This loss would be 11,460 acres, only 0.40 percent of this habitat in the entire study area. Permanent loss of habitat would probably result in the loss of some wildlife (see Table 8-53, footnote 2). This loss would not be significant; it would be small compared to the number of animals lost each year to car-animal collisions between Craig and the Wyoming border. Elk and antelope would be displaced to surrounding areas. There would be a loss of some mule deer, since the population is near carrying capacity on habitat sites. Some sage grouse would also be lost, since the loss of habitat would result in destruction of strutting grounds, which are critical for production.

These species should be absorbed by the surrounding range. Winter range for elk, mule deer, and antelope is critical habitat. Their winter range contains sagebrush, mountain shrub, and aspen types. These types make up about 30,980 acres of 45,360 total acres that would be disturbed by mining. This 30,980 acres is about one percent of the total sagebrush, mountain shrub, and aspen types available to these animals in the study area.

TABLE 8-53

ACRES OF WILDLIFE HABITAT PERMANENTLY LOST/TEMPORARILY DISTURBED AND THE NUMBER OF ANIMALS DISPLACED (HIGH-LEVEL SCENARIO)

	1978-80		1978-85		1978-90	
Total acres permanently lost	2,950	(1,350) 3/	10,280	(6,505)	16,780	(12,220)
Elk habitat lost	1,360	(621)	4,700	(3,000)	7,700	(5,600)
Elk displaced 2/	13	(6)	44	(28)	72	(50)
Deer habitat lost	2,950	(1,350)	10,280	(6,505)	16,780	(12,220)
Deer displaced 2/	58	(26)	200	(130)	330	(240)
Antelope habitat lost	885	(405)	3,080	(1,950)	5,034	(3,700)
Antelope displaced 2/	4	(2)	11	(8)	20	(15)
Sage grouse habitat lost	740	(340)	2,570	(1,630)	4,200	(3,060)
Sage grouse lost 1/	12	(6)	40	(27)	70	(50)
Total acres habitat disturbed	5,160	(470)	13,590	(3,620)	28,580	(13,780)
Elk habitat	2,370	(216)	6,250	(1,700)	13,150	(6,340)
Elk displaced 2/	22	(2)	60	(16)	125	(60)
Deer habitat	5,160	(470)	13,590	(3,620)	28,580	(13,780)
Deer displaced 2/	100	(9)	265	(70)	560	(270)
Antelope habitat	1,548	(140)	4,080	(1,090)	8,600	(1,900)
Antelope displaced 2/	14	(1)	39	(8)	75	(16)
Sage grouse habitat	1,290	(120)	3,400	(900)	7,200	(3,450)
Sage grouse lost 1/	20	(2)	60	(15)	210	(60)

1/ Sage grouse will be permanently lost since habitat disturbance is destruction of strutting grounds.
2/ Displacement of species will result in the loss of approximately 30 percent of the displaced individuals from temporary disturbance plus 50 percent from permanent disturbance.
3/ Numbers in parentheses represent losses due to development of additional federal coal.

Sage grouse losses would probably be permanent because of the loss of strutting grounds, which are critical to their survival.

Legal and illegal hunting pressure would be expected to increase with the influx in the local human population.

Animal harassment would be expected to increase as more people spend their leisure time in the country, either on the roads or in off-road vehicles, mainly snowmobiles. As a result of high-level development, big game road kills in the study area would be 1,056 animals per year by 1980, 1,300 per year by 1985, and 2,300 per year by 1990. Despite this increase, and loss of species from habitat disruption and harassment, losses due to development at high-level would not be significant compared to total wildlife populations.

Many smaller animals would be destroyed during mining, road and railroad construction, and building of homes, schools, power plants, etc. The larger and more mobile species such as deer, elk, coyote, and grouse and other birds would be able to move onto adjacent lands. Many of the displaced animals eventually could be lost as the total population would begin to adjust to the carrying capacity of the species' habitat and as animals displaced into unfamiliar territories would become more vulnerable to predation than within their home ranges. The displacement could result in a loss of 30 to 50 percent of the displaced individuals depending on species and carrying capacity.

Food and cover shortages as well as spread of disease and parasites would also increase as population densities became greater.

Impacts on wildlife related to the increased noise level, especially around the mine area, could alter feeding and movement patterns for a variety of species.

Degradation of surface water would adversely impact terrestrial wildlife, by degrading the habitat of invertebrates, a major food item of a variety of terrestrial wildlife.

Fences which would be constructed on private lands may not meet BLM Manual 1737 specifications and may account for the loss of some wildlife species. These specifications should mitigate approximately 90 percent of the fence kill loss.

Losses of individuals from high-level development would not be significant compared to the total population of these wildlife species in the study area. For example, the loss of 180 deer by 1990 averages 15 deer lost per year from 1978 to 1990. These 180 deer represent 30 percent of the 560 deer displaced by 1990. This is not significant compared to losses from disease, old age, hunting, poaching, harassment, and animal-vehicle collisions. Significance of the losses of elk, antelope, and sage grouse is even smaller.

Threatened and Endangered Species

Threatened and endangered species would not be affected by additional development of federal coal at high-level. Six species of endangered wildlife are known or believed to inhabit the study area. Four of the species are on the U.S. Department of the Interior's list of endangered fauna. These are the American peregrine falcon (Falco peregrinus), the black-footed ferret (Mustela nigripes), the whooping crane (Grus americana), and the bald eagle (Haliacetus leucoephalus). The other two, the river otter (Lutra canadensis) and the greater sandhill crane (Grus canadensis tabida) are on the State of Colorado's endangered fauna list.

Domestic Fauna

With the increased vehicle traffic discussed in the Transportation Networks section of Chapter 8, high-level, loss of livestock would increase. The loss of an animal represents an economic loss to the owner. In the study area as a whole, these losses are not expected to be significant. Accidential animal deaths would also be more likely from hunting-related activities. Rustling of livestock and damage to fences and other range improvement facilities would probably result from increases in human population and use of the region. There are no estimates of these increases available, however, they are not expected to be significant.

Loss of vegetative production would decrease the numbers of livestock that could be grazed in the areas of coal mining. These areas are southwest Routt County, southeast Moffat County, the area north of Rangely, and the area northeast of Meeker in Rio Blanco County.

Temporary disturbance of vegetation would result in a loss of vegetative production. A period of approximately 4 years following the time of disturbance would occur before reclamation would have progressed sufficiently to permit grazing. The temporary disturbance to vegetation which would occur by 1980 would result in an eventual loss of 3,600 AUMs, the additional disturbance to vegetation occurring by 1985 would result in a loss of 5,880 AUMs, and the disturbance to vegetation by 1990 would result in 10,450 AUMs lost, totaling 19,930 AUMs (Table 8-54). Of this, development of additional federal coal would cause a loss of 330 AUMs by 1980, 2,200 AUMs by 1985, and 7,080 AUMs by 1990, totaling 9,610 AUMs.

The permanent loss of production resulting from the permanent loss of vegetation would be 510 AUMs per year by 1980, 1,280 AUMs per year by 1985, and 1,130 AUMs per year by 1990 (Table 8-54). Of this, high-level additional federal coal would cause a loss of 240 AUMs per year by 1980, 900 AUMs per year by 1985, and 1,000 AUMs per year by 1990.

The resulting decrease in livestock numbers could be significant to an individual livestock operator. This cannot be determined until future coal leasing boundaries are proposed once a new federal leasing program is developed. For further discussion of economic impacts to livestock operations, see the Socio-Economic section, Chapter 8, high-level.

Changes in surface water and ground water, discussed under Water Resources, could have an effect on livestock distribution near areas of coal development. The loss of small impoundments of water or water flow from wells supplying livestock could cause a reduction in numbers of livestock that could be supported in a given area. Due to the unpredictable nature of impacts to these water supplies, it is not known if there will be a significant impact to livestock operations. Effects of ground-water on vegetation are not expected to be significant to livestock.

TABLE 8-54

LOSS OF VEGETATION PRODUCTION
AT HIGH-LEVEL (IN AUMs)

Type of loss	1980	1985	1990
Temporary (all coal-related development)	3,600	5,880	10,450
Increment due to additional development of federal coal	330	2,200	7,080
Permanent annual production (all coal-related development)	510	1,280	1,130
Permanent annual production (additional development of federal coal)	240	900	1,000

Aquatic Biology

As new coal development takes place in the study area minor adverse impacts to aquatic biology would result from population growth and developments ancillary to coal such as housing developments, power plants, and railroads. Developments at high-level would result in a permanent loss of aquatic habitat due to disturbance of land - 175 acres by 1980, 615 acres by 1985, and 1,000 acres by 1990. Disturbance due to development of additional federal coal would be 70 acres by 1980, 390 acres by 1985, and 730 acres by 1990. Destruction of habitat from accompanying increases in stream sedimentation during construction of roads, power plants, railroads, and housing developments would be localized and short-term.

Population growth would result in water treatment facilities being progressively overloaded and therefore water quality being degraded below population centers. This degradation of water quality would be long-term and would occur principally below Craig, Hayden, Steamboat Springs, and Oak Creek on the Yampa River and below Meeker and Rangley on the White River. This impact cannot be quantified because it cannot be predicted exactly what types of facilities would be constructed to treat waste.

Loss of aquatic habitat would also occur due to developments along perennial streams and increases in agriculture-related activities. Construction of housing along streams would claim cumulatively about 30 acres of aquatic habitat permanently by 1980, 185 acres by 1985, and 290 acres by 1990. Of this total, 25 acres would be attributable to development of additional federal coal by 1980, 115 acres by 1985, and 210 acres by 1990. As a result of land being disturbed for new housing, there would be more concentrated use of aquatic habitat in adjacent areas. Population growth would also create a direct loss of habitat from increases in agriculture-related activities. As more cropland would be created for farming, domestic animals would damage already limited riparian habitat.

The multiple impacts of population growth on fisheries are not expected to be of any significance, however. Areas that would be principally impacted do not have blue ribbon trout fisheries. Also, increases in sport fishing attributable to new population would not greatly affect these fisheries, but instead would increase the demand for a put-and-take trout fishery near the major population centers.

The impacts due to development of additional federal coal in comparison to total development at high-level are shown in Table 8-55.

TABLE 8-55

AQUATIC HABITAT CUMULATIVE IMPACTS (ACRES) AT HIGH-LEVEL

Impacts	1980	1985	1990
Impact due to development of additional federal coal			
Acres permanently disturbed	1,350	6,505	12,220
Aquatic habitat lost	70	390	730
Total high-level scenario impacts			
Acres permanently disturbed	2,950	10,280	16,780
Aquatic habitat lost	175	615	1,000

Threatened and Endangered Species

Threatened and endangered species of aquatic animals found in the study area would not be affected by additional development of federal coal at high-level. The White and Yampa Rivers provide habitat for the Humpback chub (Gila cypha) and the Colorado River squawfish (Ptychocheilus lucius), which are on the U.S. List of Endangered Fauna and the Colorado List of Endangered Species. The White and Yampa Rivers also provide habitat for the humpback sucker (Xyraucher texanus) and the bonytail chub (Gila elegans), the former of which is on the Colorado List of Threatened Species, the latter on the Colorado List of Endangered Species. Portions of these rivers that are habitat for these animals would not be affected by mining and related activities.

Archeological Resources

Of particular concern at high-level production are the development of the Moon Lake Electric Association mines and Rangley Power Plant and any development along the Yampa River or around Ninemile Gap. The Moon Lake Electric Association project lies between two areas of relatively high site density. Although the project area has not been surveyed, it also appears to be archeologically sensitive. The project is within 20 miles of the prehistoric sites in Dinosaur National Monument and four resources on NRHP: the Carrot Men pictographs, the Fremont Lookout Fortification site, Canyon Pintado, and the Duck Creek Wickiup Village. As population increases, the resources on NRHP, sites within the Monument, and resources throughout the western half of Moffat and Rio Blanco counties and the bordering area of Utah could be subjected to vandalism and surface collection.

Also within this 20-mile radius, 124 sites are presently recorded within and bordering the study area. It is highly probable that these sites and any unrecorded sites within this perimeter could be subjected to continual damage and disturbance.

Since Fremont stone structures and Fremont and Ute rock art are obvious and fragile, vandalism would seem to be the most dramatic impact. However, removal of diagnostic artifacts and mixing of cultural deposits at other sites would bias scientific prehistoric interpretations more profoundly. Information about prehistoric adaptations might be irretrievably lost. Development along the Yampa River could include significant sites on private leases, on state leases, in Federal Areas of Interest, and in areas used for community expansion. Prehistoric occupation here may date back as far as 10,000 years. The Ninemile Gap area is part of a natural passageway between the Yampa and White Rivers and may have been used prehistorically as a corridor between the two river basins.

Resources in the eastern portion of the study area would be subjected at high-level to impacts similar to those at mid-level and sites in western Moffat and Rio Blanco counties would begin undergoing direct and indirect impacts. In this western section there are sites which appear to be affiliated with the Desert Culture and Plains Archaic before 6,000 years ago. In the same area, sites of the Fremont Culture are presumed to date within the last 1,000 years. There are also indications of occupation by historic Utes. A table of sites on or eligible to the NRHP appears in Table 2-23. The loss of data through attrition, damage, or destruction is greater than a tally of individual resources. Loss of data would bias reconstruction of local prehistory, the prehistory of the Western Slope, and the prehistories of Wyoming, Utah, and perhaps the Great Basin and Northwestern Plains.

By 1980 the impacts from high-level production would be almost identical to those of mid-level production found in Chapter 4. Forty sites, including five eligible to NRHP, are presently recorded. Since none of the preference right lease areas and most mid-level areas have been surveyed, additional sites will be recorded. Loss of sites would occur on private leases, in the pit areas of state and federal leases, and in areas of community expansion. Community expansion at high-level development would have developed 510 acres, primarily along the White River drainage near Meeker. Of this, 430 acres would be due to the development of additional federal coal.

By 1985 impacts would occur across the study area. Forty-five sites including six recommended for nomination to NRHP are in mining areas. The additional site of NRHP quality is 5RT18 (see Table 2-23). Over 90 percent of the Federal Areas of Interest and preference right lease areas have not been surveyed so the number of sites would increase. Population growth and coal development could begin to effect sites along the Yampa River, near Ninemile Gap and in the archeologically sensitive areas near Rangely including four resources on NRHP. Community expansion would have developed 3,060 acres. Of this, 1,900 acres would be due to the development of additional federal coal. Resources in the large blocks of public land in the western portion of the study area and beyond Colorado's borders could be subjected to casual collection and vandalism. Data for comparative study and regional synthesis could be lost in Colorado, Utah, and Wyoming.

By 1990 the impacts from high-level production could possibly result in attrition of artifacts and other data and vandalism of fragile stone structures and rock art throughout the western portion of the study area and surrounding areas. Conspicuous rock art in the eastern portion may also be vandalized. The Ninemile Gap area would be involved in concentrated development. With continued population growth around Meeker, sites near the White River and its tributaries could be disturbed or destroyed. Development along the Yampa River would continue and endanger resources. Community expansion would have developed 4,860 acres. Of this, 3,540 acres would be due to the development of additional federal coal.

Throughout the time frame, the diffused impacts of collection from and destruction of sites throughout the study area and beyond described in Chapter 4 would accelerate at an unknown but probably higher rate during high-level production. Loss of data could bias sites which may date from 13,000 years ago to the late 19th century and could bias prehistoric reconstruction for western Colorado, eastern Utah, and southern Wyoming.

Eighty-two percent of the resources involved in high-level production are also involved in low-level production. Additional surveys required before high-level production begins would locate more sites. Whereas impacts at low-level production are concentrated in the eastern

portion of the study area, impacts at high-level production would occur throughout the study area but would be concentrated in three areas: near Rangely, along the Yampa River and its tributaries, and near Ninemile Gap. Some sites affected may date back as far as 13,000 years. While resources impacted at low-level appear to be of historic Ute or similar to Plains Archaic sites in Wyoming, resources impacted at high-level production may include sites affiliated with the Desert Culture of the Great Basin, the Plains Archaic, the Fremont culture of Utah, historic Utes, and may include sites of Early Plains people such as hunters of mammoths - extinct forms of bison. Loss of data at low-level production could bias reconstruction of local and Northwestern Plains prehistories. Loss of data at high-level production could bias the reconstruction of local prehistory and western slope prehistories. Important data of the movement of Fremont culture people, Northwestern Plains people, and Desert Culture people into this area may be lost. If data from the time of the hunters of mammoths are lost, reconstruction of the expansions from the High Plains' earliest occupations may be biased.

Historic Resources

The most damaging direct impact would result from earth disturbance when a specific mining site is developed; such disturbance includes roads, haulways, powerlines, portals, and structures all of which could destroy historic sites by displacement. Such sites could also be harmed by subsidence, but this impact would be minimal since lands subject to subsidence would have been inventoried and those sites located on lands prone to subsidence would have been recorded prior to development.

Secondary impacts would occur when development changes the character of a region. For instance, historic sites could be vandalized at increased rates as a result of population increases and the attendant visitor use increases. Incidences of vandalism and wood "stripping" would increase. Recreation demands on such historic areas as Hahn's Peak and Brown's Park would increase, leading to the destruction of historic sites. The development of roads, and railroads, would degrade the integrity of historic sites located in the region and near development by altering the aesthetic surrounding.

A less obvious secondary impact would result from population increases in established towns such as Craig, Steamboat Springs, Meeker, Rangely and Oak Creek. New construction would displace older buildings and sites. However, certain areas both on the city and county level that are classified or zoned historic areas would be protected from rapid undisciplined development.

Aesthetics

Visual Resources

Impacts to the study area's visual resources at high-level would vary with the size and the visual sensitivity of specific sites of additional development of federal coal.

There are several activities of mining that would create stark contrasts to the existing landscape. Those associated with surface mining are:

- spoil piles or dump areas
- active pit(s)
- clearings
- associated haul roads, electrical and water rights-of-way, railroads
- associated structures
- lights at night

Those associated with underground mining are:

- flat areas for:
  - operations structures
  - coal storage
  - equipment storage
  - road, rail, and electrical and water rights-of-way

Ratings by BLM's Visual Resource Management system to indicate adverse impacts of additional development would depend on the determination of specific sites to be leased, so none can be given at present. However, areas most vulnerable to adverse impacts to visual resources can generally be indicated.

Eastern Routt County. Most of this area is visible from U.S. 40 Colorado 131, and the Hahn's Peak Road, and therefore would be visually impacted by mining. Scenic quality in most of the area is high, because of the landscape variety generated by vegetation, topography, and rivers and streams.

Mt. Harris Area. Landscape visibility in this area is less than in eastern Routt County, although areas adjacent to U.S. 40 have great exposure for short distances and would be visually impacted by mining. View of landscapes further north and south is partially obscured by topography. Scenic quality is characteristic to outstanding in the rolling to rugged mountain-high relief topography that dominates this area, extending from the Elkhead Mountains to the north to the Dunckley Flattops to the south.

Western Routt County and Eastern Moffat County. Except for the high visual sensitivity of landscape adjacent to U.S. 40, generally visual sensitivity is moderate in this area because access is provided by county roads, which are less traveled. It would be impacted by mining.

Williams Fork Mountains. This landscape is highly visible from U.S. 40, Colorado 13, and the Williams Fork road. Further south, near the Flattops, there is only moderate to low sensitivity, because of topographical features and limited access. Areas of high sensitivity would be most impacted by mining.

Axial Basin. Visibility of the Basin's rolling interior is moderate, but all peripheral lands have a high visual exposure and would be impacted by mining activity. The Basin exhibits gently undulating landscapes of sagegrass types and agriculture, exhibiting minimal to characteristic scenic quality. Landscape variety on the Basin's periphery constitutes characteristic to outstanding scenery. Most of the eastern portion of the Basin has a high visual sensitivity, being visible from Colorado 13.

Meeker Area. Landscape visibility is moderate to high for most of the area. Yellowjacket Pass, Ninemile Gap, and the Wilson Creek Oil Field mark the Danforth Hills divide that separates the Yampa and White River drainages. East of Meeker are the White River's pastoral and agricultural lands and near the National Forest boundary are great topographic definition and vegetative variety. These lands exhibit characteristic to outstanding scenery and would be visually impacted by mining.

Rangely Area. Most of this area is only moderately visible, but there is high visual sensitivity along the Colorado Highway 64 corridor. The dominant feature of the area is the Rangely Oil Field. Outstanding scenery exists along the lower White River and the Coal Oil Rim and Pinyon Ridge, but these areas are not readily accessible and therefore would not greatly be affected visually by mining.

Blue Mountain-Skull Creek. Landscape visibility is high in this area, except for the upper Wolf Creek Area. The Skull Creek Basin and Blue Mountain exhibit outstanding panoramic views. U.S. 40 marks the southern boundary of the outstanding scenery that extends toward Dinosaur National Monument. The Wolf Creek drainage contains characteristic scenery that lies immediately north of Blue Mountain and Skull Creek. Visual sensitivity for most of the southern portion of Blue Mountain and Skull Creek is high. The remaining Wolf Creek Area is only moderately sensitive. These areas would be visually impacted by mining.

Western Moffat County north of the Yampa River. Most of the area is moderately sensitive and would be visually affected by mining. Prominant peaks and hillsides are highly visible. The landscapes of the Green River are dominant features of Browns Park with adjacent rugged mountain-high relief landscapes flanking the park on both sides, constituting outstanding scenery. Cold Springs Mountain. Vermillin, and Lodore Canyon also exhibit characteristic to outstanding scenery. Immediately south of Browns Park lies Dinosaur National Monument, containing characteristic to outstanding scenery.

Which of these visually most sensitive areas would be affected by additional development of federal coal is not known until specific sites are chosen and ancillary development indicated.

Recreation

Impacts to recreation for the high-level scenario can be divided into a decrease in the region's supply of recreation opportunities and an increase in the region's demand for outdoor recreation as a result of population increases.

When land is disturbed due to mining and ancillary developments, recreation opportunities are lost. Access to recreation lands may be blocked and the mined area's natural landscape is disturbed through removal of vegetation and modification of topography. An area may no longer be capable of attracting and sustaining dispersed recreation activities such as hiking, cross-country skiing/snowshoeing, backpacking, nature study, photography, horseback riding, collecting, camping and picnicking. Underground mining can also create hazards for recreationists. This type of mining may result in subsidence and cracking. Surface cracking presents a safety hazard to foot, horseback, and ORV use, especially motorcycles. Surface cracking is anticipated to be a minimal problem because there is a relatively small amount of underground mining associated with cumulative development at high-level.

The principal impacts to recreation would come from disturbance of the land surface. Temporary disturbance would affect 5,160 acres by 1980, 8,430 acres by 1985, and 14,990 acres by 1990 for a total of 28,580 acres. Of this, development of additional federal coal would account for 470 acres by 1980, 3,150 acres by 1985, and 10,160 acres by 1990 for a total of 13,780 acres. Of the acreage temporarily disturbed, 13,790 acres would be revegetated by 1990. Of this, 3,720 acres would be on lands disturbed due to the development of additional federal coal. Permanent disturbance would occur to 2,950 acres by 1980, 7,330 acres by 1985, and 6,500 acres by 1990 for a total of 16,780 acres permanently removed from recreation use. Of this, development of additional federal coal would account for 1,350 acres by 1980, 5,155 acres by 1985, and 5,715 acres by 1990 for a total of 12,220 acres.

This loss of recreation opportunities at high-level would occur principally in the areas of coal development, southeast Moffat County, southwest Routt County, the area northeast of Meeker, and the area north of Rangely.

Wildlife habitat would also be lost, causing displacement of animals (see Wildlife) and a loss of wildlife viewing and hunting opportunities. However, the study area has an abundance of hunting opportunities and the impact on hunting from mining should be small. The exception to this is Routt County, which had a deficit of 77,000 activity days of hunting for 1974 (Table RII-26, NWCCRES).

There would be no loss of fishing opportunities because the region's fisheries would not be impacted (see Aquatic Biology).

A beneficial impact from mining is that it would provide a human interest feature for people to view and enjoy. Mining facilities are also important educational opportunities. Other beneficial impacts from mining would be the uncovering of cultural materials, fossils, and rockhounding materials. However, these materials would generally be destroyed during mining or lost again when backfilling occurs (see Paleontology and Archeological Resources).

The population increase in the region based on the high-level scenario is: 1977 - 25,929; 1980 - 31,000; 1985 - 56,500; and 1990 - 74,500. The rate of population increase can give a rough approximation of the rate of increase in recreation demand. Regional increases in recreation demand would be 1977-1980: 20 percent (17 percent from additional federal coal at high-level), 1981-1985: 82 percent (47 percent from additional federal coal at high-level), and 1986-1990: 32 percent (29 percent from additional federal coal at high-level).

These increases in recreation demand will increase recreation deficits noted in Table RII-26 of the NWCCRES. For urban recration, Routt County has deficits of 11,200 activity days for swimming and 2,900 for tennis. Moffat County has a deficit of 14,900 activity days for tennis and 39,000 activity days for golf. Rio Blanco County did not have any deficiencies for urban recreation. Another deficit would be 77,000 activity days of hunting in Routt County. Generally, however, most activities have a large surplus of recreation supply within the region (Table RII-26, NWCCRES). This surplus of supply should be able to absorb the projected increases in recreation demand except for that noted.

Coal mining at high-level development would not occur in any areas having wilderness values. However, coal development north of Rangely would be visible from the Skull Creek area, which may have potential for designation as a wilderness area. This intrusion may decrease the quality of the potential wilderness experiences in Skull Creek.

Population increases resulting from high-level development would increase the demand for wilderness recreation in the region. Currently, the Flat Tops Wilderness Area and Mt. Zirkel Wilderness Area are the only two formally designated areas in the study area. The BLM is presently inventorying its roadless lands for wilderness potential. There is no data from which to make projections of impacts on wilderness; however, impacts would be minimal because of what appears to be a surplus of wilderness opportunities in the region. Many of these opportunities exist in areas not formally designated wilderness. A major portion of this is snowmobile use in Routt and White River National Forests. Population growth from cumulative development at high-level would be anticipated to have permanent but minimal impacts on this activity because there appears to be a regional surplus of off-road vehicle (ORV) opportunities. Assuming ORV activity would increase with population, ORV demand would increase: 1977-1980, 20 percent; 1981-1985, 82 percent; and 1986-1990, 32 percent. The impacts from ORV activity would be disruption of mood-atmosphere qualities, loss of vegetation, loss of soil and harassment of wildlife.

Recreation opportunities impacted by coal development would be considered permanent losses because, even though the land would be reclaimed, it would never again be able to attract recreation use similar to its earlier natural capability. However, reclaimed areas could provide ORV opportunities.

As population would increase, so would pressure on town's sewage treatment facilities, which would lead to increased fecal coliform levels in the Yampa and White Rivers. These increases could make the Yampa River ineligible for designation under the Wild and Scenic Rivers Act.

Socio-Economic Environment

Demography

Population growth in each jurisdiction due to additional development of federal coal at high-level is described in Table 8-56.

Additional coal-related employment within driving distance of Craig would not in the short-term fully compensate for the loss of construction jobs at the Craig Power Plant (Units 1 and 2) by 1980 (Table 8-57). Craig's population would drop by 6,400 by 1980, or 5 percent below the 1977 figure of 6,677. However, by 1985 Craig's population would reach 14,900, of which 9,400 would be due to additional development of federal coal.

Population trends in Moffat County as a whole would mirror developments in Craig: a 3 percent decline in population between 1977 and 1980, followed by a period of rapid population growth reaching 22,800 by 1990. Dinosaur would also grow steadily through 1990, when it would reach 950.

Meeker's population would grow steadily through 1990 at high-level rather than decline after 1985. Rangely would grow from 1,871 to 4,800 inhabitants by 1985 before declining to 4,600 in 1990 due to completion of nearby oil shale construction projects. Total county population would grow to 18,300 by 1990, of which 5,400 would be due to additional federal coal. Moreover, the county would maintain a steady population growth through 1990 under high-level development.

Routt County would benefit from increased coal-related expenditures and employment at high-level. Population impacts would be concentrated in Hayden (which would grow from 1,362 in 1977 to 8,700 by 1990), Oak Creek (756 to 2,700) and Steamboat Springs (4,028 to 13,000). Yampa would continue to experience moderate population growth at high-level, reaching 650 by 1990. Yampa, like several other communities, would avoid a population decline after 1985 under high-level development. High-level population of Routt County as a whole would reach 29,100 by 1990, of which 13,100 would be due to additional federal coal.

Total population of the three-county area would grow from 25,929 in 1977 to 74,500 by 1990 at high-level, 35,500 of which would be due to additional federal coal. By 1990, 86 percent of the region's population would be living in places classified as urban (i.e., over 2,500 inhabitants.

Economics

Employment. Table 8-58 presents employment projections resulting from additional development of federal coal. The high-level scenario would result in creation of 1,070 additional jobs by 1980, increasing to 7,830

TABLE 8-56

PROJECTED POPULATION RELATED TO ADDITIONAL DEVELOPMENT OF FEDERAL COAL AT HIGH-LEVEL

County City	1977	1980	1985	1990
Moffat 1/	0	2,200	9,400	17,200
Craig	0	2,200	9,000	16,600
Dinosaur	0	0	225	500
Rio Blanco 1/	0	600	2,400	5,400
Meeker	0	400	1,700	4,600
Rangely	0	100	700	800
Routt 1/	0	1,600	7,200	12,900
Hayden	0	400	2,900	5,700
Oak Creek	0	300	1,000	1,500
Steamboat Springs	0	800	3,400	4,900
Yampa	0	50	150	300
3-county area 1/		4,400	19,000	34,500

1/ Municipal totals may not equal county totals, county totals may not equal study area total due to independent rounding.

TABLE 8-57

HIGH-LEVEL CUMULATIVE POPULATION PROJECTIONS
1977-1990

County City	1977	1980	Average annual rate of change 1977-1980 1/(%)	1985	Average annual rate of change 1980-1985 1/(%)	1990	Average annual rate of change 1985-1990 1/(%)	Average annual rate of change 1977-1990 1/(%)
Moffat	10,313	10,000	- 1	19,000	14	27,100	7	8
Craig	6,677	6,400	- 2	14,900	19	22,800	9	10
Dinosaur	347	375	2	725	14	950	6	8
Rio Blanco	5,100	8,400	18	16,300	14	18,300	2	10
Meeker	1,848	4,900	38	10,100	16	12,200	4	16
Rangely	1,871	2,100	4	4,800	18	4,600	- 1	7
Routt	10,516	12,600	6	21,200	11	29,100	7	8
Hayden	1,362	2,000	14	5,100	20	8,700	11	15
Oak Creek	756	800	1	1,900	19	2,700	8	17
Steamboat Spgs	4,028	5,300	10	9,700	13	13,000	6	10
Yampa	307	375	7	525	7	650	4	6
Total	25,929	31,000	6	56,500	13	74,500	6	9

1/ Compounded annually.

TABLE 8-58

PROJECTED EMPLOYMENT ATTRIBUTABLE TO ADDITIONAL DEVELOPMENT OF FEDERAL COAL AT HIGH-LEVEL

County	1980			1985			1990		
	Direct	Indirect/ induced	Total	Direct	Indirect/ induced	Total	Direct	Indirect/ induced	Total
Moffat	110	60	170	930	790	1,720	1,340	1,330	2,670
Rio Blanco	265	40	305	660	300	960	1,200	510	1,710
Routt	465	130	595	1,830	560	2,390	2,430	1,020	3,450
Total	840	230	1,070	3,420	1,650	5,070	4,970	2,865	7,830

by 1990. Most of the additional jobs created would consist of direct coal mining employment.

Projected high-level employment due to additional federal coal would vary among individual counties: 1,710 in Rio Blanco County, 2,670 in Moffat and 3,450 in Routt by 1990. These variations reflect not only variations in the number of employees directly involved in mining in each county but also differences in the general economic structure of individual counties, which affect the extent to which the indirect and induced impacts of increased coal mining would manifest themselves locally.

Turning to the cumulative impacts at high-level (Tables 8-59, 8-60, 8-61), Moffat County would experience a drop in employment between 1977 and 1980 following completion of the Craig Power Plant, but employment would increase rapidly thereafter, reaching 8,790 by 1990, 2,670 due to additional federal coal. By 1990, Moffat County would be more dependent on coal mining as a source of employment (26 percent of total county employment), rendering the local economy correspondingly more vulnerable to disruptions in the coal market. Such disruptions could occur as a result of a prolonged nation-wide rail strike, changes in federal antipollution regulations, or a significant shift in the relative prices of coal and oil. The rapid increase in coal mining employment after 1980 could also lead to spot labor shortages in some sectors as coal mines compete with other employers for the available labor supply. In the longer term, however, any labor shortages occurring because of high-level coal development would be relieved by the arrival of new workers attracted by the expansion of local job opportunities.

Under high-level development, total 1985 employment in Rio Blanco County would be 11,360, continuing to rise to 11,780 in 1990. Over 60 percent of total 1990 employment would be directly coal, oil and gas, and oil-shale related.

Additional employment due to coal mining in Rio Blanco County, while leading to a slight increase in the county's general dependence in mine employment (including oil shale workers), would not entail significant degree of dependence on coal per se. Given the predominance of oil shale employment around 1980, labor demands of new coal development might increase spot labor shortages caused by competition between the massive oil shale construction projects and other local employers, but these shortages should be alleviated in the mid-to-long term by the arrival of new workers and the winding down of oil shale construction activities.

Finally, Routt County would experience a high-level gain in employment, reaching 11,700 by 1990, 3,450 due to additional federal coal. By 1990, direct coal mining employment would account for 31 percent of total Routt County employment. In addition to increasing Routt County's already great reliance on the coal industry as a source of employment, the increase in coal mining might lead to short-term labor shortages caused by competition among the mines and other employers. Any labor shortages caused by high-level development of coal would be short-term as new workers would move to the area, expanding the local labor force.

TABLE 8-59

HIGH-LEVEL PROJECTED EMPLOYMENT BY SECTOR
1980

Sector	Moffat		Rio Blanco		Routt	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
Agriculture	190	4	130	2	170	3
Manufacturing	140	3	60	1	150	2
Coal mining	900	18	265	4	1,245	20
Oil and gas extraction	0	0	730	12	0	0
Shale oil extraction	0	0	0	0	0	0
Construction	490	10	3,290	52	550	9
Transportation, communications, utilities	520	11	310	5	390	6
Trade	480	10	350	6	1,010	16
Finance, insurance, real estate	180	4	80	1	430	7
Services	550	11	300	5	1,120	18
State and local government	1,470	29	760	12	990	16
Federal government	90	2	50	1	100	2
Total 1/	5,010	100	6,325	100	6,155	100

1/ Total may not add to 100 percent due to rounding.

TABLE 8-60

HIGH-LEVEL PROJECTED EMPLOYMENT BY SECTOR
1985

Sector	Moffat		Rio Blanco		Routt	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
Agriculture	200	3	140	1	180	2
Manufacturing	250	3	100	1	250	3
Coal mining	1,910	25	660	6	3,020	32
Oil and gas extraction	0	0	1,040	10	0	0
Shale oil extraction	0	0	1,600	14	0	0
Construction	500	7	4,020	35	520	5
Transportation, communications, utilities	940	12	460	4	590	6
Trade	750	10	850	7	1,290	14
Finance, insurance, real estate	280	4	130	1	670	7
Services	720	10	700	6	1,380	14
State and local government	1,870	25	1,610	14	1,480	16
Federal government	110	2	60	1	130	1
Total 1/	7,530	100	11,360	100	9,510	100

1/ Total may not add to 100 percent due to rounding.

TABLE 8-61

HIGH-LEVEL PROJECTED EMPLOYMENT BY SECTOR
1990

Sector	Moffat		Rio Blanco		Routt	
	Number of employees	Percent of total employment	Number of employees	Percent of total employment	Number of employees	Percent of total employment
Agriculture	210	2	140	1	180	2
Manufacturing	310	4	180	2	320	3
Coal mining	2,240	26	1,200	10	3,650	31
Oil and gas extraction	0	0	1,560	13	0	0
Shale oil extraction	0	0	4,560	39	0	0
Construction	600	7	240	2	600	5
Transportation, communications, utilities	1,090	12	550	5	700	6
Trade	850	10	850	7	1,580	14
Finance, insurance, real estate	330	4	150	1	800	7
Services	840	10	650	6	1,730	15
State and local government	2,170	25	1,620	14	1,960	17
Federal government	150	2	80	1	180	2
Total 1/	8,790	100	11,780	100	11,700	100

1/ Total may not add to 100 percent due to rounding.

Income. Table 8-62 present projections of wage and salary earnings due to additional development of federal coal at high-level. In the study area as a whole, additional federal coal would generate $15.4 million in additional wage and salary earnings in 1980, rising to $103.4 million by 1990. Projected earnings would vary from county to county: $33.2 million in Moffat County, $23.5 million in Rio Blanco, and $46.6 million in Routt by 1990. Not only would the amount of directly mine-related wage and salary earnings vary among counties, structural variations in their economies would affect the extent of indirect and induced impacts of increased mining.

The long-term cumulative impact of high-level development on local wage and salary earnings would be greatest in Routt County, where total 1990 earnings would reach $128.5 million in 1990 (Tables 8-63, 8-64, 8-65). Average annual earnings of workers in Routt County at high-level are estimated at $10,672 in 1990, $861 due to additional federal coal. However, the higher levels of material well-being resulting from increased coal mining would carry with them long-term risks of increased dependence on a single source of income (i.e., mining), 34 percent of county wage and salary earnings by 1990. Routt County would be highly vulnerable to any disruptions in the coal market.

Moffat County would experience similar impacts, albeit of a smaller magnitude. Additional wage and salary earnings generated by high-level coal employment would help to cushion the impact of completion of the Craig Power Plant Units 1 and 2. By 1990, high-level wage and salary earnings would reach $96.1 million. This growth in aggregate earnings would be accompanied by a significant increase in the average wage and salary incomes of Moffat County residents to $11,484, of which $1,981 would be due to additional federal coal. Moffat County's degree of dependence on mining income would be increased to 36 percent of total earnings.

Under high-level development, Rio Blanco County earnings would peak at $145.5 million in 1985 before declining to $138.9 million in 1990. This would counteract the impact of economic contraction which otherwise would follow completion of the oil shale facilities and departure of construction workers.

Average wage and salary earnings among Rio Blanco County residents would also be somewhat higher in the long-term at high-level: $11,258 in 1990, of which $1,266 would be due to additional federal coal. Rio Blanco County's directly mine-related earnings at high-level would be $88.9 million in 1990. The county's proportional dependence on mine earnings at high-level would be 70 percent of total earnings.

In all three counties, increased aggreate and average wage and salary earning at high-level would intensify the inflationary effects already expected to occur in the study area without additional federal coal.

TABLE 8-62

HIGH-LEVEL INCREMENTAL WAGE AND SALARY EARNINGS
ATTRIBUTABLE TO ADDITIONAL DEVELOPMENT OF FEDERAL COAL
(thousands of dollars)

County	1980			1985			1990		
	Direct	Indirect/ induced	Total	Direct	Indirect/ induced	Total	Direct	Indirect/ induced	Total
Moffat	1,704	611	2,315	14,408	7,476	21,884	20,884	12,326	33,240
Rio Blanco	4,106	788	4,894	10,225	2,243	12,468	18,590	4,911	23,501
Routt	7,281	955	8,236	28,428	4,882	33,310	37,646	8,995	46,641
Total	13,091	2,354	15,445	53,061	14,607	67,662	77,150	26,232	103,382

TABLE 8-63

HIGH-LEVEL CUMULATIVE PROJECTED WAGE AND SALARY EARNINGS
1980

Sector	Moffat		Rio Blanco		Routt	
	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total
Agriculture	1,035	2.0	706	0.8	911	1.4
Manufacturing	1,579	3.0	647	0.7	1,623	2.5
Coal mining	13,943	26.7	4,106	4.7	19,287	29.9
Oil and gas extraction	0	0	9,671	11.1	0	0
Shale oil extraction	0	0	0	0	0	0
Construction	8,161	15.6	55,313	63.6	9,219	14.3
Transportation, communication, utilities	6,531	12.5	3,821	4.4	4,895	7.6
Trade	3,833	7.3	2,829	3.3	8,140	12.6
Finance, insurance real estate	1,409	2.7	650	0.7	3,382	5.2
Services	4,260	8.2	3,237	3.7	8,690	13.5
State and local government	10,091	19.3	5,197	6.0	6,785	10.5
Federal government	1,353	2.6	732	0.8	1,576	2.4
Total 1/	52,195	100.0	86,909	100.0	64,508	100.0
Average wage and salary earnings per worker (resident adjusted)	10,810		12,733		10,235	

1/ Totals may not add to 100.0 percent due to rounding.

TABLE 8-64

HIGH-LEVEL CUMULATIVE PROJECTED WAGE AND SALARY EARNINGS
1985

Sector	Moffat		Rio Blanco		Routt	
	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total
Agriculture	1,078	1.3	744	0.5	954	0.9
Manufacturing	2,719	3.3	1,129	0.8	2,785	2.7
Coal mining	29,590	36.1	10,225	7.0	46,786	34.5
Oil and gas extraction	0	0	13,855	9.5	0	0
Shale oil extraction	0	0	21,255	14.6	0	0
Construction	8,396	10.3	67,453	46.3	8,715	8.3
Transportation, communication, utilities	11,675	14.3	5,682	3.9	7,292	6.7
Trade	5,961	7.3	6,770	4.7	10,332	9.8
Finance, insurance real estate	2,184	2.7	1,002	0.7	5,213	5.0
Services	5,589	6.8	5,389	3.7	10,669	10.2
State and local government	12,875	15.7	11,060	7.5	10.187	9.7
Federal government	1,815	2.2	987	0.7	2,133	2.0
Total 1/	81,882	100.0	145,551	100.0	105,056	100.0
Average wage and salary earnings per worker (resident adjusted)	11,382		12,074		10,655	

1/ Totals may not add to 100.0 percent due to rounding.

TABLE 8-65

HIGH-LEVEL CUMULATIVE PROJECTED WAGE AND SALARY EARNINGS
1990

Sector	Moffat		Rio Blanco		Routt	
	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total	Thousands of 1976 dollars	Percent of total
Agriculture	1,015	1.1	766	0.6	976	0.8
Manufacturing	3,388	3.5	1,951	1.4	3,464	2.7
Coal mining	34,702	36.1	18,590	13.4	56,546	34.8
Oil and gas extraction	0	0.0	20,750	14.9	0	0.0
Shale oil extraction	0	0.0	60,535	43.6	0	0.0
Construction	10,058	10.5	4,030	2.9	10,142	7.9
Transportation, communication, utilities	13,598	14.1	6,805	4.9	8,716	6.8
Trade	6,769	7.0	6,769	4.9	12,665	9.9
Finance, insurance real estate	2,615	2.7	1,206	0.9	6,247	4.9
Services	6,502	6.8	4,986	3.7	13,359	10.4
State and local government	14,944	15.5	11,163	8.0	13,487	10.5
Federal government	2,452	2.6	1,337	1.0	2,866	2.2
Total 1/	96,133	100.0	138,888	100.0	128,468	100.0
Average wage and salary earnings per worker (resident adjusted)	11,484		11,258		10,672	

1/ Totals may not add to 100.0 percent due to rounding.

This inflation would erode local real income and would be particularly damaging to residents with low or fixed incomes. New mining and construction employees would be less severely affected than others due to their higher average income levels.

Investment. Table 8-66 lists anticipated trends in private investment at high-level. Anticipated high-level investment in the three-county area is $15 million (1976 dollars) between 1978 and 1980, $75 million between 1980 and 1985, and $55.3 million between 1985 and 1990.

All high-level investment would take place in the coal mining sector and would be distributed unevenly among Moffat, Rio Blanco and Routt Counties, but its economic effects (e.g., jobs, income) would be felt throughout the three-county area. Direct fiscal benefits in terms of increased property tax assessments on mines would be confined to county governments and school districts in which the mines are located. Nearby municipalities' property tax base would benefit only indirectly, from assessments on new worker housing and associated commercial development.

Retail Sales. Table 8-67 contains projections of retail sales under cumulative high-level coal development, expressed in 1976 dollars. Additional development of federal coal would have a major impact on areawide retail sales, which should increase rapidly from $240.2 million in 1980 to $422.9 million by 1990.

By 1990, projected retail sales at high-level would be $20.8 million in Moffat County, $10.4 million in Rio Blanco, and $33.8 million in Routt. The bulk of these impacts would be felt in the major local trade centers such as Craig, Meeker, Rangely, and Steamboat Springs.

Local Services

The impact of projected high-level population growth on local services would vary widely among individual communities. Public services and facilities in a number of communities in the three-county area, at least in the short term, would be overloaded. In most cases, however, these services should begin to catch up with the population in the middle term. In the long term, more and better services should be available to all.

Municipal service requirements at high-level are presented in Table 8-68, Police Service, Table 8-69, Fire Service, Table 8-70, Water Supply, and Table 8-71, Sewage Treatment. The following is a summary of the implications for municipal services at high-level.

Craig. Additional manpower and equipment would be needed in the police and fire departments at high-level, all due to additional development of federal coal. Water supply would be exceeded by demand by 38 percent by 1990. The sewage treatment facility would process 3.0 MGD by 1990 under

TABLE 8-66

EXPECTED MAJOR PRIVATE INVESTMENTS
BY COUNTY AT HIGH-LEVEL
(Millions of 1976 Dollars)

Sector/county	1978-1980	1981-1985	1986-1990
Non-coal investments without additional federal coal			
Moffat	90.0	50.0	0.0
Rio Blanco	1,000.0	800.0	450.0
Routt	8.3	28.2	46.2
Coal mining investments without additional federal coal			
Moffat	24.9	0.0	0.0
Rio Blanco	0.0	0.0	0.0
Routt	8.2	5.8	0.0
Additional federal coal investments			
Moffat	1.2	33.1	29.8
Rio Blanco	1.8	16.2	15.8
Routt	12.0	25.7	9.7
Total high-level investments			
Moffat	116.1	83.1	29.8
Rio Blanco	1,001.8	816.2	465.8
Routt	28.5	59.7	55.9
3-county region	1,146.4	959.0	551.5

TABLE 8-67

HIGH-LEVEL CUMULATIVE PROJECTED RETAIL SALES
1980-1990

County/ Municipality	Projected annual retail sales (thousands of dollars) 1980	1985	1990
Moffat	61,826	91,038	106,700
Craig	51,130	75,288	88,241
Dinosaur	618	910	1,067
Rio Blanco	103,970	176,005	167,858
Meeker	31,815	53,858	51,365
Rangely	61,134	103,491	98,701
Routt	74,401	113,623	148,339
Hayden	4,092	6,249	8,159
Oak Creek	1,934	2,954	3,857
Steamboat Springs	49,923	76,241	99,535
Yampa	818	1,250	1,632
Total	240,197	380,666	422,897

TABLE 8-68

POLICE SERVICE REQUIREMENTS AT HIGH-LEVEL

Town	Current service		1980 4/		1985 4/		1990 4/	
	Officers	Patrol cars	Officers	Patrol cars	Officers	Patrol cars	Officers	Patrol cars
Craig	17 (a) 2/	6 (a) 3/	13	4	25	8	39	13
Dinosaur 1/	0	0	1	1	2	1	2	1
Meeker	4 (a)	2 (h)	10	3	17	6	24	7
Rangely	4 (a)	2 (h)	4	1	10	3	9	3
Hayden	3 (a)	2 (h)	4	1	10	3	17	6
Oak Creek	1 (i)	1 (h)	2	1	4	1	5	2
Steamboat Springs	14 (a)	9 (h)	21	7	33	11	45	15
Yampa	1 (a)	1 (h)	1	1	1	1	1	1

1/ County deputy lives in the town.
2/ Assessment of current service levels based on accepted national police planning standards: (a) for towns over 10,000, 1.7 officers per 1,000 population is adequate; for towns under 10,000, 2 officers per 1,000 population is adequate; (h) indicates above average level; and (i) is below adequate level.
3/ The accepted national standard for adequate (a) patrol vehicles is 1 car per 3 officers, (h) would be less than 3 officers per car.
4/ Future service needs based on adequate service standards.

TABLE 8-69

FIRE SERVICE REQUIREMENTS AT HIGH-LEVEL

Town	Area served	Current pumping capacity 1/	1980 Required pumping capacity	1985 Required pumping capacity	1990 Required pumping capacity
Craig	Metropolitan area	2,800	2,500	4,000	4,500
Dinosaur	City limits	750	500	500	1,000
Meeker	City limits	1,225	2,250	3,000	3,500
Rangely	City limits	1,000	1,500	2,250	2,250
Hayden	Town plus radius of 10 miles county	3,250	1,500	2,250	3,000
Oak Creek	Metropolitan area	1,250	1,000	1,500	1,750
Steamboat Springs	Metropolitan area	1,250	3,500	4,500	5,000
Yampa	City limits	250	500	500	500

1/ Pumping capacity shows the combined GPM (gallons pumped per minute) of a fire department's fire fighting vehicles.

TABLE 8-70

WATER SUPPLY REQUIREMENTS AT HIGH-LEVEL

Town	Current maximum capacity (MGD) 1/	1980			1985			1990		
		Maximum 2/ demand (MGD)	Excess capacity (%)	Over capacity (%)	Maximum 2/ demand (MGD)	Excess capacity (%)	Over capacity (%)	Maximum 2/ demand (MGD)	Excess capacity (%)	Over capacity (%)
Craig	5.0	1.9	62		4.5	0		6.8		26
Dinosaur	.274	.112	59		.218	20		.285		4
Meeker	2.9	1.5	48		0		3	3.7		28
Rangely	2.16	.636	11		1.5	31		1.4	35	
Hayden	1.3 3/	.61	53		1.5		15	2.6		100
Cak Creek	1.4	.239	83		.558	60		.803	43	
Steamboat Springs (winter)	5.0	3.7	26		5.8		16	7.9		58
Yampa	1.2	.113	91		.159	87		.195	84	

1/ MGD = million gallons per day.
2/ Colorado state planning office standard for maximum (peak) daily demand = 300 gallons per day per capita.
3/ Hayden water supply currently not able to meet demand. New plant to be functioning summer 1978 with the maximum capacity of 1.3 MGD.

TABLE 8-71

SEWAGE TREATMENT REQUIREMENTS AT HIGH-LEVEL

Town	Current treatment capacity (MGD) 1/	1980			1985			1990		
		Treatment demand 2/ (MGD)	Excess capacity (%)	Over capacity (%)	Treatment demand 2/ (MGD)	Excess capacity (%)	Over capacity (%)	Treatment demand 2/ (MGD)	Excess capacity (%)	Over capacity (%)
Craig	2.5	1.1	56		2.5			3.8		52
Dinosaur	.17	.063	63		.122	28		.16	6	
Meeker	.4	.819		108	1.7		325	2.1		425
Rangely	1.7	.356	79		.813	52		.799	54	
Hayden 3/	.73	.342	54		.851		13	1.5		100
Oak Creek	.35	.134	62		.312	11		.447		28
Steamboat Springs (winter)	2.4	2.1	13		3.3		38	4.4		83
Yampa	.084	.063	25		.089		6	.109		30

1/ MGD = million gallons per day.
2/ Based on national and Colorado state planning standard of 168 gallons per day per capita.
3/ Hayden's present facility has the capacity to handle population demand through 1990. However, the system has water infiltration problems which can add up to .471 MGD to the system. Once the new facility is constructed (est. 1980-81) infiltration should no longer present a problem.

high-level, 2.7 MGD of this due to additional federal coal.

Dinosaur. Sewage treatment would meet the demand through 1990 while all other current service levels would be inadequate with additional development of federal coal.

Meeker. The sharp increase in population expected in Meeker by 1980 would begin to overload municipal services by 1980. By 1990, an increase of 17 police officers, four due to additional federal coal, would be needed. Five additional patrol cars would be needed by 1985, one due to additional federal coal. The fire department would need two additional pumpers with a combined capacity of 2,275 gpm to meet service requirements through 1990. Of this, 500 gpm would be needed due to additional federal coal. By 1985, water demand would be 3 percent above current capacity, all due to additional federal coal. Meeting the 1990 high-level demand for sewage treatment would require the current facility to be expanded to 2.1 MGD, of which 0.8 MGD would be due to additional federal coal.

Rangely. The projected high-level population would require manpower and equipment increases in the police and fire departments but the present water and sewage treatment capabilities would be adequate. By 1985, six additional police officers would be needed, two of these due to additional development of federal coal. With the projected decline in population between 1985 and 1990, the police department would need only nine officers by 1990. This decrease would probably occur through attrition in 5 years. The projected demand for fire protection would by 1985 (and through 1990) require 1,250 gpm more than the current pumping capability. An additional pumper truck would have to be purchased to bring current capacity up to standard and would need a capacity of 1,250 gpm to meet long-range requirements.

Hayden. Current problems with municipal services in Hayden would worsen at high-level. The police department would need 14 additional officers by 1990, three of these due to additional federal coal. The new town water treatment facility expected to be ready in 1978 would be adequate through 1980. By 1985, demand would be 15 percent above capacity, but with minor adjustments capacity could be increased (Margetts, personal communication, 1978) to meet water demands at high-level. Without these adjustments water demand would exceed capacity by 100 percent by 1990. The new sewage treatment plant Hayden plans to build when funding is granted by the U.S. Environmental Protection Agency would be adequate for projected high-level demand through 1990.

Oak Creek. All local services, except water, would be affected by projected high-level population. Current services with planned changes would be adequate without development of additional federal coal.

Steamboat Springs. Projected population growth at high-level would require expansion of current water and sewage treatment facilities as well as additional manpower and equipment for the police and fire departments. By 1990, the police force would need a total of 45 officers, 9 of which would be due to additional federal coal. A minimum of six police vehicles

would provide adequate service at high-level. Three additional fire trucks, each with a pumping capacity of 1,250 gpm would be needed. Water supply would need to be increased to 7.9 MGD before 1985 to meet demands of the 1990 high-level population. Similarly, sewage treatment demands in 1990 under the high-level scenario would be about 26 percent higher than without additional federal coal.

Yampa. Current police service and water supply would be adequate through 1990. The fire department needs to be upgraded in order to meet current requirements and doing so would meet required service levels at high-level through 1990. The sewage treatment facility would be over capacity by 1985 due to additional federal coal.

Housing

Population changes in northwest Colorado projected for high-level would affect housing demand, which is determined by housing preferences and the ability of residents to pay for their preferred housing type (Table 8-72).

All of the additional demand for housing in Moffat County through 1980 and over 85 percent through 1985 and 1990 would be for single family units. Availability of single family units at high-level would have to increase about 3.5 times faster than the current rate through 1990.

In Rio Blanco County, about 69 percent of additional demand by 1980 would be for mobile homes. To meet this demand, availability of mobile homes would have to increase about 35 percent annually, only 8 percent higher than the rate called for without additional federal coal, but 5.25 times the annual increase between 1970 and 1977. By 1990, about 94 percent of the additional housing demand would be for single family units. To meet this demand, availability would have to increase 26 percent faster than the current projected rate of demand without development of additional federal coal.

All of the additional high-level demand for housing in Routt County by 1980 and over 75 percent by 1985 and 1990 would be for single family units. Meeting this demand would require an annual growth rate of about 8 percent, more than twice that called for without additional development of federal coal.

At high-level, there would be more housing units in Moffat and Routt Counties through 1980 than would be needed to accommodate the population. In Moffat County, the excess would be due to population decline. The excess in Routt County would be due to the number of second homes that are not generally available for year-round rent. After 1980, expansion of the housing supply would be needed in Moffat and Routt Counties, to accommodate population increases as well as to meet demand created by changes in preference for types of housing. Expansion of the housing supply in Rio Blanco County would be needed through 1990.

At high-level, some residents in the region would be unable to live in their preferred type of housing at a cost they could afford unless demand

TABLE 8-72

HIGH-LEVEL ADDITIONAL HOUSING DEMAND

County	1977 housing units 1/	Additional housing demanded by type of unit 2/ 1980 Number	1980 Percent of total(%)	1980 Average annual growth rate 1977-1980(%)	1985 Number	1985 Percent of total(%)	1985 Average annual growth rate 1977-1985(%)	1990 Number	1990 Percent of total(%)	1990 Average annual growth rate 1977-1990(%)
Moffat										
Single family	2,069	1,095	100.0	15.2	2,628	87.4	10.8	5,175	85.9	10.1
Multiple family	584	0	0.0	0.0	123	4.1	2.4	246	4.1	2.7
Mobile homes & other	1,125	0	0.0	0.0	256	8.5	2.6	603	10.0	3.4
Total units	3,778	1,095	100.0	8.9	3,007	100.0	7.6	6,064	100.0	7.6
Rio Blanco										
Single family	1,621	222	30.8	4.4	2,220	58.8	11.4	3,529	93.8	9.3
Multiple family	225	0	0.0	0.0	388	10.3	13.4	232	6.2	5.6
Mobile homes & other	340	498	69.2	35.1	1,168	30.9	20.5	0	0.0	0.0
Total units	2,186	720	100.0	10.0	3,776	100.0	13.4	3,761	100.0	8.0
Routt										
Single family	2,851	715	100.0	7.7	2,551	77.2	8.3	5,019	81.8	8.1
Multiple family	2,132	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0
Mobile homes & other	715	0	0.0	0.0	754	22.8	9.4	1,120	18.2	7.5
Total units	5,698	715	100.0	4.0	3,305	100.0	5.9	6,139	100.0	5.8

1/ Estimates based upon State of Colorado, Division of Housing, Housing in Colorado: Estimates of Housing Inventory and Household Characteristics for January 1, 1977 and Projections of Household Growth to January 1, 1982. March, 1978.

2/ Housing "demand" is the response to a question "What type of housing would you be willing and able to move into if it were available?"

Source: Based on Construction Worker Profile, Summary Report, December, 1975.

Note: Percentages may not total 100.0 due to rounding.

for housing were to increase. Generally, availability of different types of housing would increase more rapidly than between 1970 and 1977. An exception to this would occur in Moffat and Routt Counties, where demand for mobile homes would likely be less than their projected availability based on the rate of supply from 1970 to 1977.

Education

Table 8-73 projects school district enrollment for the three counties at high-level. Following is a discussion of the implications of the projected increases for each school district.

Moffat-Craig. Under high-level development, the Craig District would expect enrollment to drop from the current 2,464 to 2,380 in 1980 (a 3.4 percent decrease), then increase to 5,154 between 1980 and 1985, and to 7,570, by 1990. Projected school district capacity would absorb increases until about 1982-83. By 1990, total enrollment would reach 7,750, of which 5,399 would be due to additional federal coal. This would be 3,790 over projected capacity. Elementary space for 2,000 and junior/senior space for 1,800 would be needed. The planned new high school will have a capacity of 900, which would be ample for expected high school enrollment increases until 1990.

Staffing shifts required to meet high-level enrollment growth would involve a decrease of 5 teaching positions between 1977 and 1980, 141 new teachers between 1980 and 1985, and 123 additional teachers between 1985 and 1990.

Rio Blanco-Meeker. Under high-level development, enrollment in the Meeker School District would increase from the current 727 to 3,886 by 1990. Of the net increase at high-level, 61 percent would be due to additional federal coal. Space for 218 additional students would be necessary by 1980, for an additional 1,575 students by 1985, and 663 by 1990. Three new elementary schools with minimum capacities of 400 each, one new junior high school with a minimum capacity of 600, and additional high school space for 300 would be needed between 1980 and 1984, with one new elementary school ready for the 1981-82 academic year.

At high-level, 50 new teachers would be needed by 1980, 85 additional teachers between 1980 and 1985, and 35 additional teachers between 1985 and 1990.

Rio Blanco-Rangely. The Rangley School District, with a current enrollment of 617, could expect increases totaling 692 by 1980 and 1,519 between 1980 and 1985, with a decrease of 100 pupils between 1985 and 1990. Six percent of the enrollment increases occurring between 1977 and 1985 would be attributable to additional federal coal. Projected school district capacity would suffice until the 1982-83 school year. Additional space for 249 pupils would be needed by 1985, but space for 62 fewer by 1990. The bulk of these increases could be absorbed through the use of modular classrooms. Additional permanent elementary space for roughly 175 students (7-8 additional classrooms) would be required to meet projected high-level enrollment increases.

TABLE 8-73

HIGH-LEVEL SCHOOL DISTRICT POPULATIONS AND ENROLLMENT PROJECTIONS

County / School district	1977				1980				1985				1990			
	Population	Elementary	Secondary	Total	Population	Elementary	Secondary	Total	Population	Elementary	Secondary	Total	Population	Elementary	Secondary	Total
Moffat																
Craig - RE #1	10,313	1,323	1,141	2,464	10,036	1,279	1,101	2,380	18,997	2,722	2,382	5,154	27,108	4,028	3,542	7,570
Rio Blanco																
Meeker - RE #1	1,848	385	342	727	4,876	873	775	1,648	10,059	1,707	1,516	3,223	12,238	2,058	1,828	3,886
Rangley - RE #4	1,871	283	334	617	2,119	323	369	692	4,838	761	758	1,519	4,635	728	729	1,457
Routt																
Hayden - RE #1	1,362	280	228	508	2,033	388	324	712	5,065	876	758	1,634	8,682	1,458	1,275	2,733
Steamboat Springs - RE #2	4,028	737	681	1,418	5,285	939	861	1,800	9,651	1,676	1,542	3,218	13,038	2,221	1,108	3,329
South Routt - RE #3	1,063	286	197	483	1,172	304	213	517	2,388	500	387	887	3,313	649	519	1,168

To maintain current pupil-teacher ratios, 5 new teachers would be needed between 1977 and 1980 and 58 additional teachers between 1980 and 1985. Between 1985 and 1990, 5 of these positions would no longer be necessary, due to enrollment decreases.

Routt-Hayden. From a current level of 508, the Hayden School District enrollment would increase to 2,733 by 1990 (Table 8-73), 78 percent attributable to additional federal coal.

Projected school district capacity would be able to handle increases until 1985, after which additional space for 1,100 students would be required. Two additional elementary schools with minimum capacities of 400 and junior-senior high school space, ideally in the form of small additions to the existing buildings for 300-400, would be needed.

To maintain current student/teacher ratios, 14 new teachers would be needed by 1980, 66 additional teachers between 1980 and 1985, and 78 additional teachers between 1985 and 1990.

Routt-Steamboat Springs. From the current 1,418, Steamboat Springs' enrollment would be expected to increase to 1,800 by 1980, 3,218 by 1985, and 3,329 by 1990. Forty-four percent of this increase would be due to additional development of federal coal.

Current and projected school district capacity would be exceeded by 1980. Potential capacity of the existing buildings, with additions, would suffice until about 1983. Thereafter, additional space for 1,000 pupils would be necessary by 1985 and for another 111 between 1985 and 1990. Of this, elementary space would be needed for approximately 700 students, secondary space for roughly 400.

To maintain current pupil/teacher ratios, 21 new teachers would be needed by 1980, 78 additional teachers between 1980 and 1985, and 6 additional teachers between 1985 and 1990.

Routt-South Routt. Projected high-level enrollment in the South Routt School District would remain relatively stable through 1980, when it would begin a gradual climb to 887 by 1985, and to 1,168 by 1990. Seventy-six percent of this increase would be due to additional development of federal coal.

Projected school district capacity would be sufficient until 1985-86, when additional space for 263 junior high students would be needed.

To maintain current pupil/teacher ratios, 2 new teachers would be needed between 1977 and 1980, 24 new teachers between 1980 and 1985, and 18 additional teachers between 1985 and 1990.

Health Care Services

Need for hospital beds are addressed on a regionwide basis. Taking

into consideration the capacity of existing hospital facilities and the current expansion of one of the hospitals, the region would face a shortage of 97 hospital beds by 1990, all due to additional development of federal coal, unless average bed utilization rates were to increase.

Table 8-74 projects the number of physicians and registered nurses needed in each county at high-level. Routt County, which currently has the most favorable population to physician ratio, would need 7 additional doctors by 1990, all due to additional federal coal, and 68 additional registered nurses, 45 due to additional federal coal. Ten additional physicians and 69 additional registered nureses would be needed in Moffat County by 1990, 9 doctors and 60 of the nurses due to additional federal coal. In Rio Blanco County, 5 more doctors, 3 due to additional development of federal coal, 38 more registered nurses, 19 due to additional federal coal, would be needed.

Recruiting additional health care specialists to the three-county area might be difficult. None of the counties has a major medical facility. Moffat and Rio Blanco Counties might have more difficulty than Routt County in recruiting additional health care specialists because neither has a recreation development such as the ski resort at Steamboat Springs.

Local Government Finances

Revenue and Expenditure Projections. Table 8-75 compares projected operating expenditures with revenues which would accrue to individual communities in the study area under high-level development. Routt and Moffat Counties would experience significant revenue surpluses due to greatly increased property tax assessments. It is not known whether they would avail themselves of these surpluses to increase their financial reserves, expand the range and level of services offered to county residents, or reduce local tax rates. Either of the latter two alternatives would result in a reduction of the projected revenue surpluses. The advent of a possible regional tax-sharing system such as that discussed in Chapter 2 would also reduce potential county surpluses by diverting a portion of county tax monies to municipal governments.

While Rio Blanco County is shown facing a potential operating deficit, revenue projections for Rio Blanco do not incorporate property taxes on future investments in shale oil facilities (see note to Table 8-75). In view of the magnitude of these investments (over $2 billion by 1990), it is certain that Rio Blanco County's long-term operating position will be favorable, but Rio Blanco would face front-end financing problems. The County would have to provide services to thousands of shale oil plant construction workers before property tax revenues would begin to flow from the completed plants.

The short-term fiscal outlook for Craig at high-level would be favorable, but the city would face a potential long-term operating shortfall reaching $479,096 by 1985 and $921,594 by 1990.

TABLE 8-74

HIGH-LEVEL NEED FOR HEALTH CARE SPECIALISTS

County	Current number 1/	1980 Total need	1980 Additional need	1985 Total need	1985 Additional need	1990 Total need	1990 Additional need
Moffat							
Physicians	4	5	1	9	5	14	10
Registered nurses	26	35	9	67	41	95	69
Rio Blanco							
Physicians	4	4	0	8	4	9	5
Registered nurses	26	29	3	57	31	64	38
Routt							
Physicians	8	6	0	11	3	15	7
Registered nurses	34	44	10	74	40	102	68

1/ 1976 for physicians.
1972 for registered nurses.

Source: Based on a population to physician ratio of 1:2,000 and a population to registered nurses ratio of 1:285.

TABLE 8-75

HIGH-LEVEL PROJECTED OPERATING REVENUES AND EXPENDITURES

	1980			1985			1990		
	Revenues	Expenditures	Surplus/deficit overrun/(short fall)	Revenues	Expenditures	Surplus/deficit overrun/(short fall)	Revenues	Expenditures	Surplus/deficit overrun/(short fall)
Counties									
Moffat	$4,953,212	$1,686,750	$3,266,462	$7,257,288	$4,552,680	$2,704,605	$10,071,810	$4,552,680	$5,519,130
Rio Blanco	1,767,845	2,058,737	1/	2,425,014	4,453,286	1/	2,660,816	4,493,286	1/
Routt	2,864,733	2,253,299	611,434	4,572,654	3,801,680	770,973	6,904,755	5,226,413	1,678,342
Cities									
Craig	3,045,333	1,950,571	1,094,762	4,094,678	4,573,774	(479,096)	6,057,804	6,979,398	(921,594)
Dinosaur	96,634	36,874	59,760	172,152	94,015	78,137	263,727	94,015	169,712
Meeker	1,158,141	719,551	438,590	2,445,535	1,805,961	639,574	3,110,721	1,805,961	1,304,760
Rangely	1,070,483	428,038	642,445	2,237,569	977,276	1,260,293	3,597,332	936,270	1,661,062
Hayden	406,162	256,972	149,190	971,364	638,120	333,244	1,787,251	1,097,404	689,847
Oak Creek	135,645	90,107	45,538	304,880	301,451	3,429	491,975	301,451	190,524
Steamboat Springs	2,955,101	2,321,647	633,454	5,019,102	4,239,587	779,515	6,871,368	5,727,463	1,143,905

1/ Rio Blanco's oil shale revenue has not been included since local authorities have not developed a formula for assessing this mineral. Local authorities state that existing formulas for property assessments would grossly misrepresent the assessed valuation. (Mr. Bloomfield, Rio Blanco County Assessor, telephone conversation, July 24, 1978).

The prospect of long-term operating shortfalls in Craig at high-level would require adjustment of its overall fiscal structure. Such a structural solution might involve levying new local taxes, implementing a tax sharing plan with other regional governments, curtailing non-essential expenditures, or some combination thereof.

Incremental Property and Sales Tax Revenues. Table 8-76 highlights the contribution of investment in coal and additional coal production at high-level to the property tax base of local governments. All of these benefits would accrue to the county rather than municipal governments since new coal mines would be situated on unincorporated county lands. Tables 8-77, 8-78, and 8-79 place these assessment increases in the context of cumulative increases in local property tax bases anticipated if high-level development were implemented.

Table 8-80, finally, relates the projected increases in local retail sales at high-level development to future sales tax collections. The latter are an important source of operating revenues in most municipalities.

Capital Funds Requirements. The preceeding portion of this discussion has focused on local communities' projected requirements for operating funds under the high-level scenario. Table 8-81, which is based on projected capital facilities requirements (see discussion of Local Services) and estimated facilities costs, contains estimates of these communities' requirements for capital funds between 1977 and 1990.

It should be possible for some communities to raise the required funds internally, i.e., out of projected operating surpluses or by bond sales. Probable exceptions include Craig, Meeker, Hayden, and Steamboat Springs. Craig would face potential capital expenditures of $13.3 million; Meeker, $15.1 million; Hayden $8.0 million; and Steamboat Springs $20.8 million during 1978-1990. Possible sources of financial assistance for these projects would include the Colorado General Assembly's project grants for emergency situations relating to sewage treatment, project grants under the Federal Water Pollution Control Act, and grants or loans from the U.S. Commerce Department Economic Development Administration.

Impact on Colorado State Finances. The total impact on state finances cannot be identified due to the limitations of the model used in this analysis. However, it is possible to identify specific revenue increases from sales tax and mineral royalties and state income tax paid by employees.

In the benchmark years of 1980, 1985, and 1990 the state will receive $24,854,846, $45,663,914, and $54,859,447, respectively, from these sources. The revenue increases above the low-level projections for these three state revenue generating items would be an estimated $16,889,096, $31,404,985, and $42,763,191, respectively, for the three benchmark years.

TABLE 8-76

HIGH-LEVEL PROJECTED INCREMENTAL TAX ASSESSMENTS ON COAL PRODUCTION AND FACILITIES
1978-1990

Additional development of federal coal under high-level scenario	Cumulative Increases 1978-1980	1978-1985	1978-1990
Facilities			
Moffat	$ 360,000	$11,090,000	$20,730,000
Rio Blanco	540,000	5,400,000	10,140,000
Routt	3,600,000	20,463,000	24,120,000
Production			
Moffat	1,874,250	3,828,250	5,527,000
Rio Blanco	367,000	3,675,000	6,909,000
Routt	1,252,000	2,223,925	2,684,000

TABLE 8-77

HIGH-LEVEL PROJECTED CUMULATIVE CHANGES IN ASSESSED VALUATION AND PROPERTY TAX REVENUES
1980

	1977 assessments		Change since 1977		Total		Mill levy		Property tax revenues
Moffat	60,246,860	+	71,175,000	=	131,420,000	X	15.65	=	2,056,752
Craig	14,968,190	+	37,722,750	=	52,690,940	X	16	=	843,055
Dinosaur	299,800	+	3,558,750	=	3,858,550	X	12	=	46,302
Rio Blanco	201,564,840	+	7,317,000	=	208,880,000	X	5.5	=	1,148,850
Meeker	5,870,240	+	4,170,690	=	10,040,930	X	8.8	=	88,360
Rangley	4,080,090	+	1,829,250	=	5,909,340	X	24.82	=	141,824
Routt	103,235,320	+	13,942,500	=	117,170,000	X	15.74	=	1,844,378
Hayden	2,389,880	+	2,091,375	=	4,481,255	X	26.05	=	116,512
Oak Creek	1,232,310	+	557,700	=	1,790,010	X	.024	=	42,960
Steamboat Springs	34,299,300	+	5,716,425	=	40,015,725	X	8.28	=	331,330

TABLE 8-78

HIGH-LEVEL PROJECTED CUMULATIVE CHANGES IN ASSESSED VALUATION AND PROPERTY TAX REVENUES
1985

	1977 assessments		Change since 1977		Total		Mill levy		Property tax revenues
Moffat	60,246,360	+	24,810,000	=	185,050,000	=	16.65	=	2,896,139
Craig	14,968,190	+	66,149,300	=	81,117,490	=	16	=	1,297,879
Dinosaur	299,800	+	6,240,500	=	6,540,300	X	12	=	78,483
Rio Blanco	201,564,840	+	60,602,400	=	262,160,000	X	5.5	=	1,441,919
Meeker	5,870,240	+	34,543,368	=	40,413,608	X	8.8	=	355,639
Rangley	4,080,000	+	15,150,600	=	19,230,690	X	24.82	=	477,305
Routt	103,235,320	+	68,271,000	=	171,500,000	X	15.74	=	2,699,509
Hayden	2,389,880	+	10,240,650	=	12,630,530	X	26.05	=	329,025
Oak Creek	1,232,310	+	2,730,840	=	3,963,150	X	24	=	95,115
Steamboat Springs	34,299,300	+	27,991,110	=	63,290,410	X	8.28	=	516,262

TABLE 8-79

HIGH-LEVEL PROJECTED CUMULATIVE CHANGES IN ASSESSED VALUATION AND PROPERTY TAX REVENUES
1990

	1977 assessments		Change since 1977		Total		Mill levy		Property tax revenues
Moffat	60,246,860	+	231,250,000	=	291,490,000	X	15.65	=	4,561,925
Craig	14,968,190	+	122,560,000	=	137,530,000	X	16	=	2,200,491
Dinosaur	299,800	+	11,562,500	=	11,862,300	X	12	=	142,347
Rio Blanco	201,564,840	+	131,220,000	=	332,780,000	X	5.5	=	1,830,323
Meeker	5,870,240	+	74,796,540	=	80,666,780	X	8.8	=	709,867
Rangley	4,080,080	+	32,880,500	=	36,870,734	X	24.82	=	915,500
Routt	103,235,320	+	172,800,000	=	276,030,000	X	15.74	=	4,344,795
Hayden	2,389,880	+	25,920,000	=	28,309,880	X	26.05	=	737,472
Oak Creek	1,232,310	+	6,912,000	=	8,144,310	X	24	=	195,463
Steamboat Springs	34,299,300	+	70,848,000	=	105,140,000	X	8.28	=	870,619

TABLE 8-80

HIGH-LEVEL PROJECTED ANNUAL RETAIL SALES TAX REVENUES
(thousands of dollars)

County City	1980	1985	1990
Moffat	$1,494	$2,202	$2,580
Craig	766	1,136	1,323
Dinosaur	9	13	16
Rio Blanco 1/			
Meeker	318	539	514
Rangely	611	1,035	987
Routt 1/			
Hayden	82	125	163
Oak Creek	19	30	39
Steamboat Springs	998	1,534	1,990

1/ Rio Blanco and Routt Counties do not levy a sales tax.

TABLE 8-81

HIGH-LEVEL PROJECTED CAPTIAL NEEDS AND COST
(thousands of dollars)

City	Activity		
	Fire trucks	Water systems	Sewer facilities
Craig	75	2,736	10,504
Dinosaur	75	16	-
Meeker	150	2,216	13,736
Rangely	75	-	-
Hayden		1,976	6,060
Oak Creek	75	-	783,760
Steamboat Springs	225	4,408	16,160

Utilites

Purchase of electricity from companies outside the region would be necessary if demand for electricity within northwest Colorado were to exceed the power generating capacity of the electricity suppliers, Moon Lake Electric Association and the Colorado-Ute Electric Association, supplier of power to the Yampa Valley and White River Electric Associations.

Increased pipeline capacity for natural gas would be necessary to meet high-level needs. In the short run, facility constraints would create distribution problems for natural gas companies because current demand for natural gas is almost at pipeline capacity and two to three years are needed for pipeline capacity to be increased. Under the high-level development, projected population would be 19 percent higher by 1980 than 1977 so there would be adequate lead time to increase pipeline capacity to meet projected high-level demands by 1985 and 1990. In addition to increased pipeline capacity, additional natural gas reserves would also be needed.

Transportation Networks

Impacts on transportation networks would be caused by (1) transportation of coal out of the study area, and (2) increased employment and population, with its attendent increase in vehicles and miles traveled. Due to the greater level of coal production at high-level, impacts would be greater than those discussed for mid- and low-level.

Highways

Based on population projections for Routt, Moffat and Rio Blanco counties and a factor of 1.24 vehicles per person (NWCCES - 1976), vehicle registrations at high-level would be 38,400 by 1980, 70,100 by 1985, and 92,400 by 1990. Increases attributable to additional federal coal would be 5,200 by 1980, 23,600 by 1985, and 43,900 by 1990. Table 8-82 presents the incremental increase of the average daily traffic volumes at selected points in the study area. Traffic would increase to 924,000 vehicle-miles by 1980, to 1,139,000 vehicle-miles by 1985, and to 2 million by 1990. Of this, 344,000 would be attributable to new federal coal by 1980, 513,000 by 1985, and 1,315,000 by 1990 (Table 8-83). Traffic volume increases at high-level would also result in more accidents, by 1980, 3,430 accidents per year in the study area, 3,790 by 1985, and 3,850 by 1990. Accidents attributable to additional development of federal coal would be 980 by 1980, 1,090 by 1985, and 1,340 by 1990. Additional heavy truck traffic on roads in the study region would cause faster deterioration of roads and increased maintenance costs. See Tables 8-41, 8-42, and 8-43 for information on development of new mining-related roads. These increases would be large and heavily impact existing highway networks.

Railroads

The amount of rail traffic generated by the region would be expected to increase to 422,500 carloads by 1990. This amounts to about 75 percent of coal production being handled by rail in 1990. Movement of this volume of traffic would require an average of 29 80-car trips or 23.5 100-car train trips daily (one unit train going only one way from Denver to Craig equals one trip). This level of rail use would tend to limit coal movements from West Central Colorado and Central Utah to the "Tennessee Pass" route, which in turn, may serve as a limiting factor to development of coal resources in these regions. The D&RGW has indicated that it would make improvements to the main-lines in its system if future traffic demands would warrant. Among the types of improvements which could be undertaken would be the construction of longer sidings, alternate sections of single and double track, double tracking, or improving the Tennessee Pass route to permit the handling of longer trains.

The higher volume of traffic would greatly increase the levels of impacts discussed in Chapter 4, in particular, in the Front Range communities through which this traffic would pass. See table 8-41, 8-42, 8-43, and 8-44 for information on new rail development in the study area.

TABLE 8-82

TRAFFIC VOLUMES AT SELECTED POINTS IN THE
STUDY AREA AT HIGH-LEVEL
(UNITS: AVERAGE DAILY TRAFFIC)

Location		1980	1985	1990
US 40	at Utah State Line	3,190	3,064	1,832
US 40	W/o Dinosaur	3,840	3,632	4,990
US 40	E/o Dinosaur	2,960	2,834	3,780
US 40	E/o Rd to Blue Mtn	2,530	2,530	3,290
US 40	W/o Jct SH 318	2,850	2,580	3,660
US 40	E/o Jct SH 318	3,330	3,080	4,230
US 40	W/o W Jct SH 13	7,410	6,653	9,380
US 40	E/o W Jct SH 13	15,240	14,320	19,480
US 40	W/o E Jct SH 13	28,730	26,790	39,060
US 40	E/o E Jct SH 13	16,720	16,020	22,230
US 40	W/o Hayden	4,130	46,070	5,350
US 40	E/o Hayden	3,610	4,550	5,380
US 40	W/o Milner	3,820	4,210	4,980
US 40	W.C.L. Steamboat Springs	8,696	9,820	11,670
US 40	S.C.L. Steamboat Springs	11,508	13,208	15,960
US 40	5 Mi S/o Jct 131	2,874	3,340	3,910
SH 131	S/o Jct US 40	1,730	2,050	2,270
SH 131	N/o Oak Creek	1,487	1,670	1,880
SH 131	N/o Phippsburg	1,455	1,590	1,770
SH 131	S/o Phippsburg	1,105	1,210	1,440
SH 131	S/o Yampa	913	1,100	1,180
SH 13	Colorado-Wyoming State Line	3,020	2,900	4,240
SH 13	N.C.L. Craig	4,690	4,574	6,390
SH 13	S/o US 40	9,882	9,170	13,040
SH 13	N/o Hamilton	5,850	5,280	7,380
SH 13	S/o Hamilton	5,850	5,280	7,380
SH 13	at Rio Blanco-Moffat Co.Line	4,900	4,440	6,110
SH 13	E.C.L. Meeker	7,070	12,080	13,510
SH 13	E/o Jct SH 64	5,880	10,340	11,540
SH 13	S/o Jct SH 64	4,756	8,440	9,610
SH 317	E/o Jct SH 13	388	360	500
SH 394	S.C.L. Craig	11,681	11,690	18,240
SH 394	2 Mi S/o Craig	4,780	4,460	6,980
SH 64	W/o Jct SH 13	3,470	6,220	6,970
SH 64	4 Mi W/o Jct SH 13	2,870	5,310	5,960
SH 64	E/o Jct SH 139	4,320	7,980	8,970
SH 64	W/o Jct SH 139	5,220	9,360	10,480
SH 64	W.C.L. Rangely	6,990	11,640	13,110
SH 64	W/o Blue Mtn Rd	5,364	8,930	9,960
SH 64	E/o Bonanza Rd	3,160	5,760	6,460
SH 64	at Rio Blanco-Moffat Co.Line	3,160	5,760	6,460
SH 139	S/o SH 64	1,570	2,540	3,130

SH: State Highway
N/o: North of
S/o: South of
E/o: East of
W/o: West of
N.C.L.: North City Limits
S.C.L.: South City Limits
E.C.L.: East City Limits
W.C.L.: West City Limits

Source: Colorado State Department of Highways

TABLE 8-83

INCREASES IN TRAFFIC VOLUMES ATTRIBUTABLE TO
ADDITIONAL FEDERAL COAL AT HIGH-LEVEL
(UNITS: AVERAGE DAILY TRAFFIC)

Location		1980	1985	1990
US 40	at Utah State Line	1,790	1,584	2,620
US 40	W/o Dinosaur	2,200	1,872	3,110
US 40	E/o Dinosaur	1,790	1,584	2,450
US 40	E/o Rd to Blue Mtn	1,510	1,440	2,130
US 40	W/o Jct SH 318	1,790	1,440	2,450
US 40	E/o Jct SH 318	2,060	1,720	2,780
US 40	W/o W Jct SH 13	5,500	4,610	7,200
US 40	E/o W Jct SH 13	10,200	8,930	13,730
US 40	W/o E Jct SH 13	21,730	19,300	31,070
US 40	E/o E Jct SH 13	11,000	9,650	15,210
US 40	W/o Hayden	1,100	1,300	1,640
US 40	E/o Hayden	690	1,300	1,800
US 40	W/o Milner	960	1,010	1,470
US 40	W.C.L. Steamboat Springs	2,200	2,450	3,430
US 40	S.C.L. Steamboat Springs	3,300	3,740	5,230
US 40	5 Mi S/o Jct 131	690	860	1,140
SH 131	S/o Jct US 40	410	580	650
SH 131	N/o Oak Creek	275	320	390
SH 131	N/o Phippsburg	410	430	490
SH 131	S/o Phippsburg	280	290	430
SH 131	S/o Yampa	220	330	330
SH 13	Colorado-Wyoming State Line	2,340	2,160	3,430
SH 13	N.C.L. Craig	2,750	2,450	4,090
SH 13	S/o US 40	7,290	6,340	9,970
SH 13	N/o Hamilton	4,680	4,030	6,050
SH 13	S/o Hamilton	4,680	4,030	6,050
SH 13	at Rio Blanco-Moffat Co.Line	3,990	3,460	5,070
SH 13	E.C.L. Meeker	4,260	9,070	10,300
SH 13	E/o Jct SH 64	3,850	8,210	9,320
SH 13	S/o Jct SH 64	3,300	6,910	8,010
SH 317	E/o Jct SH 13	220	170	290
SH 394	S.C.L. Craig	8,660	8,210	13,730
SH 394	2 Mi S/o Craig	3,990	3,600	6,050
SH 64	W/o Jct SH 13	2,480	5,180	5,890
SH 64	4 Mi W/o Jct SH 13	2,200	4,610	5,230
SH 64	E/o Jct SH 139	3,440	7,060	8,010
SH 64	W/o Jct SH 139	3,710	7,780	8,830
SH 64	W.C.L. Rangely	4,130	8,640	9,970
SH 64	W/o Blue Mtn Rd	3,440	6,910	7,850
SH 64	E/o Bonanza Rd	2,340	4,900	5,560
SH 64	at Rio Blanco-Moffat Co.Line	2,340	4,900	5,560
SH 139	S/o SH 64	830	1,670	2,130

SH: State Highway
N/o: North of
S/o: South of
E/o: East of
W/o: West of
N.C.L.: North City Limits
S.C.L.: South City Limits
E.C.L.: East City Limits
W.C.L.: West City Limits

Source: Colorado State Department of Highways

As a result of both increased train and auto traffic, the incidence of auto-train collisions at unseparated grade crossings would increase. The cumulative hazard ratings for crossing in the study area are 8.13 for 1976, 9.70 by 1980, 16.88 by 1985, and 19.06 by 1990. The increase in hazard ratings due to additional development of federal coal at high-level are 1.49 by 1980, 8.58 by 1985, and 10.66 by 1990. Hazard ratings are the number of auto-train collisions expected in a 5-year period.

As a result of increased train traffic, the average daily vehicle waiting time at unseparated grade crossings would increase. Assuming a three-minute delay per train, daily vehicle waiting time at high-level would increase from the present 12 minutes per day to 17 minutes per day by 1980, 36 minutes by 1985, and 43 minutes by 1990. Delays attributable to development of additional federal coal at high-level would be 3 minutes by 1980, 21 minutes by 1985, and 30 minutes by 1990. This would be especially significant to emergency vehicles, which would have no alternate route. The impact to emergency services is difficult to quantify because there is no data on the probability of an emergency vehicle being delayed in the study area.

SUMMARY OF IMPACTS AT LOW-, MID-, AND HIGH-LEVEL

Following is Table 8-84, which summarizes impacts that would occur as a result of development at low-, mid-, and high-level.

TABLE 8-84

SUMMARY TABLE OF IMPACTS AT LOW-, MID-, AND HIGH-LEVEL

Environmental Element	Nature of Impact 1/	Low-level	Mid-level 2/	High-level 2/
Geologic Setting				
Topography	Permanent disturbance of land for ancillary development and housing.	1,600 acres by 1980, 2,175 more by 1985, and 785 more by 1990.	2,740 (1,140) acres by 1980, 4,500 (2,315) more by 1985, and 7,330 (2,500) more by 1990.	2,950 (1,350) acres by 1980, 7,330 (5,155) more by 1985, and 6,500 (5,715) by 1990.
	Temporary disturbance of land for mining, to be progressively reclaimed (see Vegetation).	4,690 acres by 1980, 5,280 more by 1985, and 4,830 more by 1990.	5,160 (470) acres by 1980, 7,310 (2,030) more by 1985, and 7,330 (2,500) more by 1990.	5,160 (470) acres by 1980, 8,430 (3,150) more by 1985, and 14,990 (10,160) more by 1990.
	Subsidence and tension cracks, primarily where longwall method used in underground mines.	Not quantifiable, but would increase where longwall method is used rather than room & pillar method.	See low-level.	See low-level.
Paleontology	Loss of plant, invertebrate, and vertebrate fossil materials for scientific research and public education, etc., through mining.	Not quantifiable, but would increase with greater extent of coal development, and proximity to sensitive areas.	See low-level.	See low-level.
	Exposure of fossil materials for scientific examination and collection.	Not quantifiable, but would increase with greater extent of coal development and proximity to sensitive areas.	See low-level.	See low-level.
	Loss of paleontological materials due to unauthorized collecting and vandalism.	Not quantifiable, but would increase as population increases.	See low-level.	See low-level.
Mineral Resources	Removal of coal.	Rate of removal: 16.6 million tons/year by 1980, 18.2 million by 1985, and 15.9 million by 1990; total: 224.68 million tons by 1990.	Rate of removal: 20.3 (3.7) million tons/year by 1980, 27.5 (9.3) million by 1985, and 28.3 (12.4) million by 1990; total: 320.65 (95.97) million tons by 1990.	Rate of removal: 20.8 (4.2) million tons/year by 1980, 43.2 (25.0) million by 1985, and 56.3 (40.4) million by 1990; total: 449 (224) million tons by 1990.
	Unrecovered coal due to losses inherent in mining methods; 50 percent recovery by underground, 90 percent by surface mining methods.	Total of 79 million tons would not be recovered.	Total of 130 million tons would not be recovered.	Total of 207 million tons would not be recovered.
	Conflicts in mineral development: oil and gas vs. coal rarely occur; coal vs. uranium not known at this time. Sequential recovery normally employed.	Impacts not quantifiable, but would probably not exceed those accruing to separate recovery.	See low-level.	See low-level.
Water Resources				
Ground Water	Removal of parts of certain aquifers and dewatering of mines would lower water levels locally.	Loss of a few springs.	See low-level.	Loss of less than 1 percent of existing springs.

1/ Only significant impacts are listed.

TABLE 8-84 (Cont.)

SUMMARY TABLE OF IMPACTS AT LOW-, MID-, AND HIGH-LEVEL

Environmental Element	Nature of Impact 1/	Low-level	Mid-level 2/	High-level 2/
Ground Water (cont.)	Increase in dissolved solids concentration in Colorado River below Hoover Dam attributable to coal development: any increase would be significant because current levels exceed desirable limits.	1.0 mg/l by 1980, 6.4 mg/l by 1985, and 7.0 mg/l by 1990.	1.1 (0.1) mg/l by 1980, 6.9 (0.5) by 1985, and 7.6 (0.6) by 1990.	1.1 (0.1) mg/l by 1980, 7.7 (1.3) by 1985, and 10.0 (3.0) by 1990.
Surface Water	Reduction in flow to Lower Basin States.	Not significant.	See low-level.	Very small, but any reduction would be impact.
Climate	Climate would not be significantly affected by coal mining activity except for some small, extremely localized, temporary effects.	See Climate, low-level, Chapter 8.	See Climate (mid-level), Chapter 4.	See Climate, high-level, Chapter 8.
Air Quality	As population would increase, maximum allowable levels under state and federal standards would be approached and sometimes exceeded for total suspended particulates, SO_2, NO_2, CO, and non-methane hydrocarbons, principally around major towns.	See Air Quality, low-level, Chapter 8.	See Air Quality (mid-level), Chapter 4.	See Air Quality, high-level, Chapter 8.
	Although there would be little increase in total suspended particulates and non-methane hydrocarbons near towns, existing baseline levels for them already exceed existing air quality standards.	See Air Quality, low-level, Chapter 8.	See Air Quality (mid-level), Chapter 4.	See Air Quality, high-level, Chapter 8.
	Visibility around point sources of particulates (in cities and around mines) would sometimes be diminished, but would increase rapidly short distances from point sources.	See Air Quality, low-level, Chapter 8.	See Air Quality, (mid-level), Chapter 4.	See Air Quality, high-level, Chapter 8.
Soils	Surface disturbance: see Topography. Soil productivity would be permanently lost on soils permanently disturbed, temporarily lost on soils temporarily disturbed.	See Topography.	See low-level.	See low-level.
	Naturally developed soil horizons, structure, parent material, soil micro-climates, permeability, and infiltration rates would all be lost or reduced on all disturbed soils.	6,290 acres by 1980, 7,455 more by 1985, and 5,615 more by 1990.	7,900 (1,610) acres by 1980, 11,810 (4,345) more by 1985, and 9,060 (3,455) more by 1990.	8,110 (1,820) acres by 1980, 15,760 (8,305) more by 1985, and 21,490 (15,875) more by 1990.
	Loss of exposed soils by wind and water erosion.	Not quantifiable, but would increase as development increases.	See low-level.	See low-level.
	Loss of soils due to ORV use; see Recreation.	Not quantifiable, but would increase proportional to population.	See low-level.	See low-level.
Vegetation	Removal of vegetation: see Topography.	See Topography.	See low-level.	See low-level.

1/ Only significant impacts are listed.
2/ All numbers in parentheses (except 1980, 1985, 1990) indicate that portion of the preceding number (cumulative development at the given level) which is attributable to additional federal coal.

TABLE 8-84 (Cont.)

SUMMARY TABLE OF IMPACTS AT LOW-, MID-, AND HIGH-LEVEL

Environmental Element	Nature of Impact 1/	Low-level	Mid-level 2/	High-level 2/
Vegetation (cont.)	Reclamation (regrading to original contour and revegetation) of temporarily disturbed soils.	100 acres by 1980, 4,690 more by 1985, and 5,280 more by 1990.	200 (100) acres by 1980, 5,160 (470) more by 1985, and 7,130 (2,030) more by 1990.	200 (100) acres by 1980, 5,160 (470) more by 1985, and 7,130 (2,030) more by 1990.
	Unavoidable temporary loss of production on temporarily disturbed soils.	3,480 AUMs by 1980, 3,920 more by 1985, and 3,580 more by 1990.	3,830 (350) AUMs by 1980, 5,420 (1,510) more by 1985, 5,440 (1,860) more by 1990.	3,600 (330) AUMs by 1980, 5,880 (2,200) more by 1985, and 10,450 (7,080) more by 1990.
	Permanent loss of production on permanently disturbed soils (expressed as rate of loss per year).	300 AUMs/year by 1980, 700 AUMs/year by 1985, and 850 AUMs/year by 1990.	510 (210) AUMs/year by 1980, 1,340 (640) by 1985, and 1,660 (820) by 1990.	510 (240) AUMs/year by 1980, 1,280 (900) by 1985, and 1,130 (1,000) by 1990.
	Loss of vigor and diversity, successional stage. Time to reestablish vegetative ecosystem would be long-term.	20 to 50 years to reestablish vegetative ecosystem.	See low-level.	See low-level.
	Over utilization of adjacent areas by wildlife and domestic fauna.	Chiefly affect domestic fauna; impact localized, not quantifiable.	See low-level.	See low-level.
Animals				
Wildlife	Some destruction of habitat, displacement of game animals, roadkills; destruction of less mobile species. Threatened and endangered species not affected.	No significant impacts.	See low-level.	See low-level.
Domestic Fauna	Loss of production, temporary and permanent (see Vegetation)	Small, localized, not quantifiable.	See low-level.	See low-level.
Aquatic Biology	Permanent loss of aquatic habitat due to disturbance of land; would not affect blue-ribbon game fisheries. (Loss expressed as cumulative total).	95 acres by 1980, 225 acres by 1985, and 275 acres by 1990.	165 (70) acres by 1980, 435 (200) acres by 1985, and 540 (265) acres by 1990.	175 (70) acres by 1980, 615 (390) acres by 1985, and 1,000 (730) acres by 1990.
	Degradation of water quality due to overtaxing sewage facilities as population increases (also see Recreation).	Not quantifiable.	See low-level.	See low-level.
Cultural Components				
Archeological Resources	Uncovering of archeological materials and inventorying and recording of sites otherwise not discovered, but materials lost for application of better archeological analysis methods developed in future.	Not quantifiable, but would increase as areal extent of coal development increases.	See low-level.	See low-level.
	Casual collection would result in loss or mixing of diagnostic data used to interpret interrelationships between prehistoric peoples and their environments. Loss cannot be assessed.	Not quantifiable, but losses would probably increase proportional to population.	See low-level.	See low-level.
	Loss of unidentified surface and buried sites where community expansion would occur. Loss cannot be assessed.	Not quantifiable, but would increase with community expansion.	See low-level.	See low-level.

1/ Only significant impacts are listed.
2/ All numbers in parentheses (except 1980, 1985, 1990) indicate that portion of the preceding number (cumulative development at the given level) which is attributable of additional federal coal.

TABLE 8-84 (Cont.)

SUMMARY TABLE OF IMPACTS AT LOW-, MID-, AND HIGH-LEVEL

Environmental Element	Nature of Impact 1/	Low-level	Mid-level 2/	High-level 2/
Cultural Components (cont.) Archeological Resources (cont.)	Loss of paleoecological data on federal and non-federal leases. Loss cannot be assessed.	Not quantifiable, but would increase as areal extent of coal development increased.	See low-level.	See low-level.
	Loss or disturbance of recorded and unidentified surface or buried sites in lease areas and rights-of-way. Loss cannot be assessed.	Not quantifiable, but would increase as areal extent of coal development increased.	See low-level.	See low-level.
	Loss of archeological resources because of subsidence above underground mines. Loss cannot be assessed.	Not quantifiable, but would increase as areal extent of coal development increased.	See low-level.	See low-level.
Historic Resources	Increased vandalism of historic sites. Loss cannot be assessed.	Not quantifiable, but would increase with population.	See low-level.	See low-level.
	Destruction of "historic atmosphere" in towns where older structures displaced by new construction. Loss cannot be assessed.	Not quantifiable, but would increase with population.	See low-level.	See low-level.
Aesthetics	Impacts to landscape character: (1) support facilities for new population, (2) mining on steep slopes, (3) surface facilities not blending with landscape, and (4) construction of roads, railways, and electric distribution lines on steep terrain or bedrock material contrasting with surrounding landscape. Impact cannot be assessed.	Not quantifiable until specific mining operations and associated ancillary facilities are developed.	See low-level.	See low-level.
	Dust, pollution, and noise would adversely affect aesthetic quality of general area. Impact cannot be assessed.	Not quantifiable until specific mining operations and associated ancillary facilities are developed.	See low-level.	See low-level.
Recreation	Deficiencies in swimming, golf, and tennis opportunities in Routt and Moffat Counties, hunting opportunities in Routt County.	Not quantifiable, but would increase as population increases.	See low-level.	See low-level.
	Mining provides human-interest and educational opportunities.	Not quantifiable.	See low-level.	See low-level.
	Increased use of developed recreation sites in study area.	Not quantifiable, but would increase proportional to population.	See low-level.	See low-level.
	With disturbance of land for mining and ancillary construction (see Topography), loss of foot, ORV, and viewing opportunities. Subsidence could also be hazardous to these activities after reclamation.	Not quantifiable.	See low-level.	See low-level.
	With increases in population, increases in coliform levels (see Aquatic Biology) on White and Yampa Rivers; Yampa could be ineligible for designation under Wild and Scenic Rivers Act. Also, possible curtailment or prohibition of water-contact sports.	Not quantifiable.	See low-level.	See low-level.

1/ Only significant impacts are listed.
2/ All numbers in parentheses (except 1980, 1985, 1990) indicate that portion of the preceding number (cumulative development at the given level) which is attributable to additional federal coal.

TABLE 8-84 (Cont.)

SUMMARY TABLE OF IMPACTS AT LOW-, MID-, AND HIGH-LEVEL

Environmental Element	Nature of Impact 1/	Low-level	Mid-level 2/	High-level 2/
Cultural Components (cont.) Socio-Economic Environment	Increase in population due to coal mining activity would affect all three counties. Most of Rio Blanco's growth would be attributable to oil shale projects. Population levels for the three counties in 1977 are: Moffat - 10,313; Rio Blanco - 5,100; Routt - 10,516.	Moffat County: 7,800 (1980), 9,600 (1985), 9,900 (1990). Rio Blanco: 7,900 (1980), 13,900 (1985), 12,900 (1990). Routt: 11,000 (1980), 14,000 (1985), 16,200 (1990).	Moffat County: 9,100 (1980), 14,000 (1985), 17,700 (1990). Rio Blanco: 8,000 (1980), 15,500 (1985), 14,500 (1990). Routt: 12,200 (1980), 19,100 (1985) 22,200 (1990).	Moffat County: 10,000 (1980), 19,000 (1985), 27,100 (1990). Rio Blanco: 8,400 (1980), 16,300 (1985), 18,300 (1990). Routt: 12,600 (1980), 21,200 (1985), 29,100 (1990).
	Employment in mining would have direct and indirect impacts on Moffat and Routt Counties, very little impact on Rio Blanco.	See Tables 8-18 to 8-20.	See Tables 4-21 to 4-23.	See Tables 8-59 to 8-61.
	The bulk of economic growth in the three counties would be concentrated in the coal mining sector. Routt and Moffat Counties would be economically vulnerable to fluctuations in the coal market.	In Routt: coal mining would constitute 21% of total earnings by 1980, 25.3% by 1985, and 23% by 1990. In Moffat, 24.5%, 25.3%, and 22%, respectively.	In Routt, coal mining would constitute 30% of of total earnings by 1980, 40% by 1985, 38% by 1990. In Moffat, 27%, 27%, and 25%, respectively.	In Routt, coal mining would constitute 30% of total earnings by 1980, 34.5% by 1985, 34% by 1990. In Moffat, 26.7%, 36.1%, and 36.1%, respectively.
	Direct fiscal benefits would accrue to Routt and Moffat Counties through property tax assessments on mines; also to school districts in which mines located. Indirect benefits to nearby municipalities, through assessments on new private and commercial property.	See Investment Patterns, low-level, Chapter 8. Implications complex for Local Government Finances.	See Investment Patterns, (mid-level) Chapter 4. Implications complex for Local Government Finances.	See Investment Patterns, high-level, Chapter 8. Implications complex for Local Government Finances.
	Public services including fire, police, water, and sewage would be taxed, some beyond capacity.	See Local Services, low-level, Chapter 8.	See Local Services (mid-level), Chapter 4. Sewer and water become deficient in some towns by 1985-90.	See Local Services, high-level, Chapter 8. Sewer and water become deficient in some towns by 1985-90.
	In Moffat and Routt Counties, demand for additional housing would be predominantly for single family dwellings. In Rio Blanco County, demand would shift away from mobile homes (1980) toward single-family (1990).	Average annual growth rate for all housing 1977-1990: Moffat, 1.6%; Rio Blanco, 6.1%; Routt, 2.3%.	Average annual growth rate for all housing 1977-1990: Moffat, 4.4%, Rio Blanco, 6.9%; Routt, 4.9%.	Average annual growth rate for all housing 1977-1990: Moffat, 7.6%, Rio Blanco, 8.0%, Routt, 5.8%.
	Education: fluctuations in school enrollment would reflect changes in population.	See Table 8-31.	See Table 4-35.	See Table 8-73.
	The region would experience growing deficiencies in health care. There would be difficulties recruiting physicians and nurses.	See Table 8-32.	See Table 4-36.	See Table 8-74.
	Moffat and Routt Counties would experience significant increases in revenue surpluses due to greatly increased property tax assessments from mines.	See Local Government Finances, low-level, Chapter 8. Would be affected by investments by private industry (see Investment Patterns).	See Local Government Finances (mid-level), Chapter 4. Would be affected by investments by private industry (see Investment Patterns).	See Local Government Finances, high-level, Chapter 8. Would be affected by investments by private industry (see Investment Patterns).

TABLE 8-84 (Cont.)

SUMMARY TABLE OF IMPACTS AT LOW-, MID-, AND HIGH-LEVEL

Environmental Element	Nature of Impact 1/	Low-level	Mid-level 2/	High-level 2/
Cultural Components (cont.)				
Socio-Economic Environment (cont.)	Purchase of electricity from companies outside the region would be necessary. Increased pipeline capacity for natural gas would also be needed.	See Utilities, low-level, Chapter 8. Adequate lead-time exists for increasing pipeline capacity.	See Utilities (mid-level), Chapter 4. Adequate lead-time exists for increasing pipeline capacity.	See Utilities, high-level, Chapter 8. Adequate lead-time exists for increasing pipeline capacity.
Transportation Networks	With increases in population, increases in hazard ratings at railroad crossings (projected ratings for entire study area).	8.21 by 1980, 8.30 by 1985, and 8.40 by 1990.	8.21 (2.87) by 1980, 8.30 (3.60) by 1985, and 8.40 (4.60) by 1990.	9.70 (1.49) by 1980, 16.88 (8.58) by 1985, and 19.06 (10.66) by 1990.
	Also, increases in daily vehicle-waiting time for trains (projected total of all waiting time for study area).	14 minutes/day by 1980, 15 by 1985, and 13 by 1990.	17 (3) minutes/day by 1980, 23 (8) by 1985, and 23 (10) by 1990.	17 (3) minutes/day by 1980, 36 (21) by 1985, and 43 (30) by 1990.
	Roads designed for lighter traffic would receive heavy use due to transportation of coal; deterioration hastened (see Tables 1-3 through 1-6).	Not quantifiable, but would increase with coal development and coal haulage.	See low-level.	See low-level.
	More accidents would occur as population increases (projected total of all accidents in the study area).	2,090 by 1980, 2,300 by 1985, and 2,510 by 1990.	2,450 (360) by 1980, 2,700 (400) by 1985, and 3,000 (490) by 1990.	3,430 (980) by 1980, 3,790 (1,090) by 1985, and 3,850 (1,340) by 1990.

1/ Only significant impacts listed.
2/ All numbers in parentheses (except 1980, 1985, 1990) indicate that portion of the preceding number (cumulative development at the given level) which is attributable to additional federal coal.

CHAPTER 9

CONSULTATION AND COORDINATION

This chapter contains a brief description of the interagency team organization and a list of federal, state, and local agency contacts as well as non-government organizations and people contacted in preparation of this report.

INTERAGENCY ROLE IN PREPARING THE NW SUPPLEMENTAL REPORT

A memorandum from the Office of the Secretary of the Interior assigned the Colorado State Director, Bureau of Land Management, lead responsibility for preparation of this study. The project was organized as a joint effort between the Bureau of Land Management (BLM) and the U.S. Geological Survey (USGS). BLM was responsible for preparing the regional analysis, which includes evaluation of regional environmental impacts on public lands administered by the BLM, on private land overlying federal leases of subsurface coal, and on private land and coal to be developed in conjunction with federal leases.

The USGS contributed core members for the NW Supplemental Report team. These members contributed expertise in the areas of minerals, mining, hydrology, paleontology, topography, stratigraphy, and geomorphology.

LIST OF ORGANIZATIONS CONSULTED IN PREPARING THE
NW SUPPLEMENTAL REPORT

Governmental Organizations

Federal

Washington Office
Bureau of Land Management
Washington, D.C.

Craig District
Bureau of Land Management
Craig, Colorado

Montrose District
Bureau of Land Management
Montrose, Colorado

State Office
Bureau of Land Management
Denver, Colorado

Rawlins District
Bureau of Land Management
Rawlins, Wyoming

Rock Springs District
Bureau of Land Management
Rock Springs, Wyoming

Advisory Council on
Historic Preservation
Denver, Colorado

Bureau of Reclamation
Office of Design and Construction
Denver, Colorado

National Park Service
Mesa Verde National Park

National Park Service
Washington, D.C.

U.S. Department of Agriculture
Forest Service Region 2
Rocky Mountain Region
Denver, Colorado

Smithsonian Institution
Department of Anthropology and
  Office of Dillon Ripley
Washington, D.C.

Senior Staff Specialist
  for Endangered Species
Fish and Wildlife Service
Region 6
Denver, Colorado

U.S. Department of Agriculture
Soil Conservation Service
Colorado State Office
Denver, Colorado

U.S. Department of Agriculture
Soil Conservation Service
Grand Junction Area (No. 1) Office
Grand Junction, Colorado

U.S. Department of Agriculture
Soil Conservation Service
Craig Soil Survey Office
Craig, Colorado

U.S. Department of Agriculture
Soil Conservation Service
Meeker Soil Survey Office
Meeker, Colorado

State

Colorado Division of Wildlife
Fort Collins, Colorado

Colorado Division of Wildlife
Grand Junction, Colorado

Colorado Division of Wildlife
Craig, Colorado

Colorado Division of Wildlife
Steamboat Springs, Colorado

Colorado Division of Wildlife
Yampa, Colorado

Colorado Division of Wildlife
Glenwood Springs, Colorado

Colorado Division of Wildlife
Hayden, Colorado

Colorado State Department
of Highways
Denver, Colorado

University of Colorado
Department of Anthropology
Boulder, Colorado

State Historical Society of Colorado
Denver, Colorado

Colorado State University
Department of Anthropology
Fort Collins, Colorado

Lowie Museum of Anthropology
University of California
Berkeley, California

University of Oklahoma
Department of Anthropology
Norman, Oklahoma

Kentucky Heritage Commission
Frankfort, Kentucky

University of Oregon
Department of Anthropology
Eugene, Oregon

Pennsylvania Historical and
Museum Commission
Harrisburg, Pennsylvania

Appalachian State University
Department of Sociology
and Anthropology
Boone, North Carolina

University of Rhode Island
Department of Sociology
and Anthropology
Kingston, Rhode Island

Virginia Historic Landmarks
Commission
Richmond, Virginia

University of Utah
Department Of Anthropology
Salt Lake City, Utah

Wyoming Recreation Commission
Office of the
Wyoming State Archeologist
Laramie, Wyoming

Southern Colorado State College
Department of Anthropology
Pueblo, Colorado

Western Carolina University
Department of Sociology and
Anthropology
Cullowhee, North Carolina

University of North Carolina
Research Laboratories
of Anthropology
Chapel Hill, North Carolina

Historical Preservation Office
Salt Lake City, Utah

Local

Planning Department
Moffat County
Craig, Colorado

Planning Department
Rio Blanco County
Meeker, Colorado

Planning Department
Routt County
Steamboat Springs, Colorado

Non-Governmental Organizations and Individuals

Empire Energy Company
Craig, Colorado

Utah International Inc.
San Francisco, California

Coal Fuels Company
Rollinsville, Colorado

Moon Lake Electric
Roosevelt, Utah

Utah International Inc.
Salt Lake City, Utah

W.R. Grace & Company
Craig, Colorado

American Electric Power
Lancaster, Ohio

Pittsburg & Midway Coal Mining
Company
Oak Creek, Colorado

Mined Land Reclamation Board
Denver, Colorado

Blazer Fuels Corporation
Boulder, Colorado

Kemmerer Coal Company
Kemmerer, Wyoming

Ranchers
Craig, Colorado

Rancher
Meeker, Colorado

Land Owner
Steamboat Springs, Colorado

Colowyo Coal Company
Craig, Colorado

Ranchers
Steamboat Springs, Colorado

Rancher
Axial, Colorado

Energy Fuels Company
Steamboat Springs, Colorado

Sheridan Enterprises
Englewood, Colorado

Utah International, Inc.
Craig, Colorado

Energy Fuels Corporation
Steamboat Springs, Colorado

Peabody Coal Company
Denver, Colorado

Denver & Rio Grande Western
Railroad
Denver, Colorado

American Anthropological Association
Anthropology Newsletter
San Diego, California

American Museum of Natural History
Department of Anthropology
New York, New York

Museum of the American Indian
Heye Foundation
New York, New York

Peabody Museum
Harvard University
Cambridge, Massachusetts

The Peabody Museum of Natural History
Yale University
New Haven, Connecticut

VTN
Denver, Colorado

Wenner-Gren Foundation
for Anthropological Research
Current Anthropology
Vancouver, British Columbia, Canada

Museum of Northern Arizona
Flagstaff, Arizona

COORDINATION IN REVIEW OF THE NW SUPPLEMENTAL REPORT

The following federal and state agencies and local government entities and interested groups have been supplied with copies of this report. Any comments received will be used in preparation of future environmental analysis concerning possible future federal coal development in the northwest Colorado region.

Governmental Organizations

Federal

Advisory Council on Historic Preservation
Department of Agriculture
- Soil Conservation Service
- U.S. Forest Service

Department of Commerce
Department of Defense
- Army Corps of Engineers

Department of Energy
- Conservation and Energy Resource Development Division

Environmental Protection Agency
Federal Energy Regulatory Commission
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
- Bureau of Reclamation
- Bureau of Mines
- Fish and Wildlife Service
- Heritage Conservation and Recreation Service
- National Park Service
- Office of Surface Mining
- U.S. Geological Survey

Interstate Commerce Commission
Department of Labor
- Occupational Safety and Health Administration
- Mining Health and Safety Administration

Office of Economic Opportunity
Office of Management and Budget
Rural Electrification Administration
Department of Transportation
- Federal Highways Administration

Water Resources Council

State

Copies of the NW Supplemental Report will be sent to the State of Colorado Clearing House for distribution to interested state agencies.

Local

All entities included under the local contacts heading of the previous section (List of Organizations Consulted in Preparing the NW Supplemental Report) will be sent copies of the NW Supplemental Report.

Non-Governmental Organizations

AMAX
American Camping Association
American Canoe Association
American Electric Power Service Corporation
American Institute of Mining Engineers
American Metals Climax, Inc.
American Mining Company
American Research Corporation
American Sportmens' Club
Anschutz Uranium Corporation
Atlantic Richfield Company
Atlas Minerals
Atomic Industrial Forum, Inc.
Audubon Society
Cities Service Company
Coal Fuels Corporation
Coastal States Energy Company
Colorado Association of Commerce and Industry
Colorado Association of Soil Conservation Districts
Colorado Cattlemen's Association
Colorado Clean Water Action Project
Colorado Environmental Health Association
Colorado Farm Bureau
Colorado Four Wheel Drive Clubs, Inc.
Colorado Mining Association
The Colorado Mountain Club
Colorado Open Space Council
Colorado Parks and Recreation Society
Colorado Petroleum Association
Colorado River Water Conservation District
Colorado Rivers Council
Colorado Sportsman's Association
Colorado University Wilderness Group
Colorado-Ute Electric Association, Inc.
Colorado Water Conservation Board
Colorado Wildlife Federation, Inc.
Colorado Wool Growers Association
Colowyo Coal Company
Commonwealth Coal Company
Conservation Association
Conservation Foundation
Consolidation Coal Company, Inc.

Defenders of Wildlife
El Paso Natural Gas Company
Ember Mining Company
Empire Energy Corporation
Energy Fuels Corporation
Environmental Action of Colorado
Environmental Corps (Colorado State University)
Environmental Defenders, Inc.
Environmental Defense Fund
Environmental Policy Institute
EXXON Company
FOCERI
Friends of the Earth
Getty Oil Company
W.R. Grace & Company
Gulf Mineral Resources Co.
Gulf Oil Company
Homestake Mining Company
Hunt Energy Corporation
Institute of Behavioral Sciences
International Engineering Co., Inc.
International Society for the Protection of Mustangs & Burros
Izaak Walton League of America
Keep Colorado Beautiful, Inc.
Kerr-McGee Corporation
League of Women Voters
MAPCO Coals, Inc.
Merchants Petroleum Company
Midland Coal Company
Mobile Oil Corporation
Mono Power Company
Montana Environmental Quality Council
Moon Lake Electric Association
Mountain Area Planning Council
Mountain Bell
Mountain States Telephone & Telegraph
MSCRB
Murphy/Williams Urban Planning & Housing Consultants
National Association of Conservation Districts
National Council of Public Land Users
National Energy Law & Policy Institute
National Environmental Health Association
National Geographic Society
National Resources Defense Council
The Nature Conservancy
North Park Game & Fish Association
NUS Corporation
Pacific Gas & Electric Company
Peabody Coal Company
Phillips Coal Company
Phillips Petroleum
Pittsburg & Midway Coal Mining Company

Public Service Company
PURE
Radian Corporation
Recreational Use of Public Land
Reserve Oil & Gas Company
Rochester & Pittsburgh Coal Company
Rocky Mountain Association of Geologists
Rocky Mountain Center on Environment
Rocky Mountain Energy Company
Rocky Mountain Federation of Mineralogical Societies
Rocky Mountain Mineral Law Foundation
Rocky Mountain Sportsmen Federation
Routt-Moffat Woolgrower's Association
Ruby Construction Company
Shell Oil Company
Sierra Club
Sierra Club Legal Defense Fund
Society for Range Management
Stearns-Roger, Inc.
Sunoco Energy Development
Texaco
Texas Gulf
Texas Utilities Fuel Company
Thorne Ecological Institute
Trout Unlimited
United States Steel Corporation
URS Company
Utah International, Inc.
Visintainer Sheep Company
VTN
Western Governors Regional Energy Policy Office
White River Electric Association
The Wilderness Society
The Wildlife Society
R. Withers Coal
Wyoming Petroleum Association
Wyoming Wildlife Federation
Yampa Valley Electric
Yampa Valley Environmental Action Group
Zapata Colorado Mining Corporation

APPENDIX A

Federal and State Regulations Governing and Requiring Permits — Section 1

Cooperative Agreement Between the Federal Government and the Colorado State Mine Reclamation Board — Section 2

Archeology — Section 3

- Table 1: Consultation Efforts with Academic Institutions and Museums to Learn of Un-Published Surveys or Excavations in the Study Region
- Table 2: Consultation Efforts with Academic Institutions and Museums to Verify Whether Cherokee Indians had Traveled in the Study Region in 1848 or 1849

Historic Resources — Section 4

- Table 1: Historic Resources within the Northwest Supplemental Report Area
- Table 2: Sites Recorded Since 1975 That Do Not Appear to Qualify for the National Register of Historic Places

Aquatic Biology: Addendum to the Species List in Table IX-1 of the Northwest Colorado Coal Regional Environmental Statement (NWCCRES) — Section 5

Colorado Water Quality Standards for Class B_1 or B_2 Waters — Section 6

SECTION 1:

Federal and State Regulations Governing and Requiring Permits

SECTION 1

FEDERAL AND STATE REGULATIONS GOVERNING
AND REQUIRING PERMITS

Action	Regulations
Federal:	
Lease Issue	43 CFR 3500
Exploration License	43 CFR 3507
Major Drainage Effects	33 CFR 209
Explosives License	18 USC 40
Air and Water Quality	40 CFR 52
State Notification	PL 92-500
Lease Identity	30 CFR 82
Ventilation and Roof Support Approval	30 CFR 77
Mining and Reclamation Plan Approval	43 CFR 3041 30 CFR 211
Preparation Plant	40 CFR 60
Clearance of Sale of Variety Mineral	43 CFR 3610 36 CFR 251
Radio Use	Communication Act of 1934
Railroad Spur	ICC
Pollution Discharge	PL 92-500
Right-of-Way Permit	PL 94-579
State:	
Air Pollution	CRS 25-7-101, 1970
Water Discharge	CRS 25-8-501, 1973
Solid Waste	CRS 30-20-103 and 104, 1973
Sewage Disposal	CRS 20-10-104, 1973 CRS 25-20-107, 1973
Site Application	CRS 25-8-101
Waste Water Treatment	CRS 25-9-101
Potable Water Supply	CRS 25-1-107
Radioactivity License	CRS 25-11-101
Erosion Control Dams	CRS 37-87-122
Diesel Permit	Bulletin 20, Colorado Division of Mines Memorandum CMI-52
Booster Fans	CRS 1973, Title 34, Article 25, Section 102
Roof Control	CRS 1973, Title 34, Article 26,
Major Drainage Effect	CRS 25-8-202 and 205
Exempt Well	CRS 37-92-602
Small Capacity Well	CRS 37-92-105
Well Construction	CRS 37-90-137
Use of Ground Water	CRS 37-90-108

FEDERAL AND STATE REGULATIONS GOVERNING
AND REQUIRING PERMITS

Action	Regulations
Explosives License	CRS 1973, Title 34, Article 27, Section 101-110 CRS 1973, Title 34, Article 47, Section, 103-104 CRS 1973, Title 9, Article 7
Coal Mine License	CRS 1973, Title 34, Article 23, Section 101
Prospecting Permit	CRS 1973, Title 34, Article 32, (as amended)
Development and Extraction	CRS 1973, Title 24, Article 32, (as amended)
State Interest Areas	House Bill 1041

SECTION 2:

Cooperative Agreement Between the Federal Government and the Colorado State Mine Reclamation Board

Title 30—Mineral Resources

CHAPTER II—GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

PART 211—COAL MINING OPERATING REGULATIONS

JUL 6 19
GEOLOGICAL SURVEY
DENVER, COLO.
AREA MINING

Adoption of Procedures to Govern Surface Coal Mining Reclamation Operations on Federal Coal Leases in Colorado

AGENCY: Geological Survey, Interior.

ACTION: Final rule.

SUMMARY: This document adopts as Federal regulations a Cooperative Agreement between the Department of the Interior and the State of Colorado that governs the administration and enforcement of reclamation laws affecting Federal coal leases in Colorado. These regulations will minimize the duplication of existing Federal and State administration and enforcement actions on Federal coal leases.

EFFECTIVE DATE: July 1, 1977.

FOR FURTHER INFORMATION CONTACT:

Robert Uram, Office of the Solicitor, U.S. Department of the Interior, Washington, D.C. 20240, 202-343-4803.

SUPPLEMENTARY INFORMATION: On May 23, 1977, the Department proposed to enter into a Cooperative Agreement with Colorado that would govern the administration and enforcement of reclamation standards on federal coal leases in Colorado. 42 FR 26218. The proposed agreement gives Colorado the basic responsibility for enforcing coal reclamation standards in that State.

The Agreement is made under regulations to govern the management of federally owned coal resources that the Department adopted on May 17, 1976. 41 FR 20252. Those regulations authorize the Department to enter into cooperative agreements with states in which Federal coal leases have been or will be issued for the purpose of avoiding duality in the administration and enforcement of surface coal mine reclamation operations. 30 CFR 211.75(b).

A fuller explanation of the background of this agreement may be found in the preamble to the proposal and in the pre-

28, 1977

nble to the May 17, 1976, regulations.

The Department allowed public comment on the proposed adoption of the Cooperative Agreement until June 6, 1977; no comments were received.

Only 1 change from the proposal has been made in the final rules published today: an effective date of July 1, 1977, has been inserted in the Cooperative Agreement.

Dated: June 22, 1977.

CECIL D. ANDRUS,
Secretary.

1. Title 20 CFR 211.10 is amended by adding a new paragraph (e)(6) to read as follows:

§ 211.10 Exploration and mining plans.

• • • • •

(e) *States with § 211.75(b) agreements.* • • •

(6) Colorado. A Federal coal lessee in the State of Colorado who must submit a mining plan or permit under both State and Federal law shall submit in lieu of the mining plan required in this section, a mining plan containing the information required by.

(i) 34-32-112, C.R.S. (1973);

(ii) Colorado Mined Land Reclamation Board Rules and Regulations, Rule 2, Section 2.1 (referred to as "Board Rule");

(iii) 30 CFR 211.10(c); and

(iv) A statement certifying that a copy of the plan has been given to the State of Colorado and the Secretary.

2. Title 30, § 211.74 is amended by adding a new paragraph (g)(6) to read as follows:

§ 211.74 Variances.

• • • • •

(g) *States with § 211.75(b) agreements* • • •

(6) Colorado. A Federal coal lessee in the State of Colorado shall request and receive variances from the State of Colorado and the Secretary under the provisions of 30 CFR 211.74.

3. Title 30 § 211.77 is amended by adding a new paragraph (f) to read as follows:

§ 211.77 States with cooperative agreements.

• • • • •

(f) Colorado. The administration and enforcement of reclamation requirements on federal coal leases in Colorado subject to this part shall be done according to the Cooperative Agreement between the State of Colorado and the Department of the Interior. The Cooperative Agreement is published at [date and page of publication of final rule to be inserted], and is available at appropriate offices of the Department of the Interior.

4. The State of Colorado and the Department of the Interior enter into a Cooperative Agreement to designate the State of Colorado as the principal party to administer surface coal mine reclamation operations on Federal coal leases in Colorado to read as follows:

Cooperative Agreement Between the United States Department of the Interior and the State of Colorado under Section 32 of the Mineral Leasing Act of 1920, 30 U.S.C. Section 189, and Section 307 of the Federal Land Policy and Management Act of 1976, and 30 CFR 211.75(b).

This agreement (referred to as the Cooperative Agreement) is made between the State of Colorado acting by and through Governor Richard D. Lamm (referred to as the Governor) and the United States Department of the Interior, acting by and through the Secretary of the Interior (referred to as the Secretary).

ARTICLE I—PURPOSE

This Cooperative Agreement provides for a cooperative program between the United States Department of the Interior and the State of Colorado with respect to the administration and enforcement of coal surface mine reclamation requirements under coal leases issued by the Department of the Interior under the Mineral Leasing Act of 1920. The basic purpose of the agreement is to prevent duality of administration and enforcement of surface reclamation requirements by designating the State of Colorado to the extent possible, as the principal entity to enforce reclamation laws and regulations on Federal coal leases in Colorado.

ARTICLE II—EFFECTIVE DATE

The Cooperative Agreement is effective on the 1st day of July, 1977, and remains in effect until terminated as provided in Article IX.

ARTICLE III—REQUIREMENTS FOR COOPERATIVE AGREEMENT

The Governor affirms that the State of Colorado will comply with all of the provisions of this Cooperative Agreement and will continue to meet all the conditions and requirements specified in this Article upon which the approval of the Secretary is based.

A. *Responsible Administrative Agency.* The Colorado Department of Natural Resources and the Colorado Mined Land Reclamation Board (referred to as the State Agency) are, and shall continue to be, the agencies responsible for administering this Cooperative Agreement on behalf of the Governor on Federal coal leases throughout the State.

B. *Authority of State Agency.* The State Agency designated in Paragraph A of this Article has, and shall continue to have, authority to carry out this Cooperative Agreement.

C. *State Reclamation Law.* The State Agency shall ensure that all mining plans approved under this agreement shall afford general protection of the environment at least as stringent as would occur under the exclusive application of 30 CFR part 211, and that the standards used to approve a mining plan of a Federal lessee will not unreasonably impair coal mining that is in the overriding national interest.

D. *Effectiveness of State Procedures.* The existing procedures of the State of Colorado shall be, in the judgment of the Secretary, substantially as effective for the purpose of enforcing the reclamation requirements of 30 CFR part 211 as the procedures of the Department of the Interior.

E. *Inspection of Mines.* The Governor affirms that the State Agency will inspect all mines on Federal coal leases located in the State, in accordance with the minimum schedule in Article V.

F. *Enforcement.* The Governor affirms that the State Agency will enforce the Agreement in a manner that ensures effective environmental protection.

G. *Qualified Personnel.* The State Agencies will have an adequate number of fully qualified personnel necessary for the enforcement of this Cooperative Agreement.

H. *Funds.* The State Agency will, subject to appropriations from the Colorado General Assembly, devote adequate funds for the administration and enforcement of reclamation requirements on Federal coal leases in the State.

I. *Reports and Records.* The State Agencies shall make reports to the Secretary, containing information about its compliance with the terms of this Cooperative Agreement, as the Secretary shall from time to time require. The State Agencies shall also make available to the Secretary, upon request, information developed under this Cooperative Agreement.

The Secretary affirms that the Department of the Interior will comply with all of the provisions of this Cooperative Agreement.

ARTICLE IV—MINE PLANS

Federal regulations, 30 CFR 211.10(c), and State laws and regulations require that the operator of lands leased, permitted or licensed for coal mining receive approval of a mining plan or permit prior to conducting operations.

A. *Contents of Mining Plans and Permits.* The State Agencies and the Secretary agree that a Federal coal lessee must submit a mining plan or permit application under both State and Federal law, which plan or permit must include, at a minimum, the following information:

1. The information required by:

a. 34-32-112, C.R.S. (1973);

b. Colorado Mined Land Reclamation Board Rules and Regulations, Rule 2, Section 2 (referred to as "Board Rule"); and

c. 30 CFR 211.10(c).

2. A Statement certifying that a copy of the mining plan or permit application has been given to both the State Agency and the Secretary.

If either the State Agency or the Secretary requires the operator to submit additional information the operator shall submit the information to both the State Agency and the Secretary. The operator will request variances from the mining plan in accordance with 30 CFR 211.74, and shall file the request with the State Agency and the Secretary.

B. *Review of Plan.* The State Agency and the Secretary shall each review and analyze the adequacy of the plan, permit, or request for an amendment or a variance from the plan or permit.

C. *Approval of Mining Plans.* The State Agency shall review the adequacy of the mining plan or permit or any request for a variance from a plan as provided in 34-32-10 and 34-32-112. The State Agency shall notify the Secretary of its action pursuant to such provisions. The Secretary shall then independently review and take action on the mining plan or permit as required by 30 CFR 211.10(d), or request for a variance as required by 30 CFR 211.74, or a change to an approved mining plan or permit which was acted upon by the State Agency. The Secretary shall notify the State Agency of his action and the State Agency shall reconsider the action if necessary to comply with this Cooperative Agreement.

ARTICLE V—INSPECTIONS

A. The State Agency shall inspect as authorized by 34-32-121, C.R.S. (1973), and Board Rule 8, Section 8.1, as frequently as necessary but at least quarterly the operations area of all Federal Coal leases, permits and licenses where operations affecting the reclamation of mined lands are conducted or are to be conducted, for the purpose of determining whether the operator is complying with all applicable laws, regulations and orders and all requirements of approved mining plans that affect the reclamation of

mined lands. The State Agency shall also perform all inspections required under 30 CFR 211.41. Such inspections performed in accordance with 30 CFR 211.41 shall be considered in meeting the quarterly inspection requirement.

B. The State Agency will, subsequent to conducting any inspection, file with the Secretary a report on (1) the general conditions of the lands under coal lease, permit or license, (2) the manner in which the operations are being conducted and (3) whether the operator is complying with applicable reclamation requirements. A copy of this report shall be furnished to the operator on request, and shall be made available for public inspection during normal business hours at the offices of the Federal Mining Supervisor

C. For the purpose of evaluating the manner in which the Cooperative Agreement is being carried out and to ensure that reclamation is being effectively performed, the Secretary may inspect from time to time mines on Federal coal leases within the State. Inspections by the Secretary may be made in association with the regular inspection by the State Agency.

D. The Secretary may conduct inspections on Federal coal leases to determine whether the operator is complying with requirements that are unrelated to reclamation.

ARTICLE VI—ENFORCEMENT

A. If the State Agency determines that the operator is not complying with a requirement that relates to the reclamation of lands disturbed by surface mining, it shall take such steps as required by 34-32-124, C.R.S. (1973), and Board Rule 8, Section 8.2.

B. If, in the judgment of the State Agency, an operator is conducting activities on lands subject to this Agreement which fail to comply with a requirement that relates to reclamation and those activities threaten immediate and serious damage to the environment, the State Agency shall take immediate action, as authorized by 34-32-124 (2), C.R.S. (1973).

C. The State Agency shall notify the Secretary of all violations of applicable laws regarding reclamation on Federal coal leases including violations of Federal laws and regulations or lease terms and of all actions taken under 34-32-124, and Board Rule 8, Section 8.2.

D. This section does not limit the Secretary's authority to seek cancellation of a Federal coal lease under Federal laws and regulations, or prevent the Secretary from taking appropriate steps to correct actions that violate Federal law, but not State law, or from taking appropriate measures to remedy violations of a mining plan or other appropriate requirements.

E. Failure to adequately enforce the reclamation laws and regulations shall be grounds for termination of this Cooperative Agreement.

ARTICLE VII—SURETY OR BONDS

A. *Amount and Responsibility.* The State Agency may require Federal coal lessees subject to the provisions of 30 CFR Part 211 to submit surety as provided in 34-32-117, C.R.S. (1973). The Secretary shall reduce the Federal bond required for reclamation purposes under 43 CFR 3041.3 and 30 CFR 211.3, by the amount of the surety required by the State Agency only if the release of all or any portion of the State Agency's surety is conditioned on compliance with the requirements of the approved plan, and the amount released is appropriate to the work completed. Where the surface of the lands is not owned by the United States, the State Agency shall notify the surface owner and solicit and take into account his comments before recommending release of the surety.

B. *Notification.* Prior to releasing the surety provided for in 34-32-117, C.R.S. (1973), for lands the surface on which is owned by the Federal Government, the State Agency shall consult with and seek the advice and consent of the Secretary.

C. *Release of Surety.* The State Agency shall hold the operator responsible and liable for successful reclamation as required by 34-32-117, 34-32-118, C.R.S. (1973).

ARTICLE VIII—OPPORTUNITY TO COMPLY WITH COOPERATIVE AGREEMENT

The Secretary may, at his sole discretion, and without instituting or commencing proceedings for withdrawal of approval of the Cooperative Agreement, notify the State Agency that it has failed to comply with the provisions of the Cooperative Agreement. The Secretary shall specify how the State Agency has failed to comply and shall state the period of time within which the defects in administration shall be remedied and satisfactory evidence presented to him that the State Agency has remedied the defects in administration and is in compliance with and has met the requirements of the Secretary. The time period specified shall not be less than 30 days. Upon failure of the State Agency to meet the requirements of the Secretary within the time specified, the Secretary may institute proceedings for withdrawal of approval of the Cooperative Agreement as set forth in Article IX.

ARTICLE IX—TERMINATION OF COOPERATIVE AGREEMENT

The Cooperative Agreement may be terminated as follows:

A. *Termination by the State.* The Cooperative Agreement may be terminated by the Governor upon written notice to the Secretary, specifying the date upon which the Cooperative Agreement shall be terminated, but which date of termination shall not be less than 60 days from the date of the notice.

B. *Termination by the Secretary.* The Cooperative Agreement may be terminated by the Secretary whenever the Secretary finds, after giving due notice to the State Agency and affording the State Agency an opportunity for a hearing:

1. That the State Agency has failed to comply substantially with any provision of the Cooperative Agreement; or

2. That the State Agency has failed to comply with any assurance given by the State Agency upon which the Cooperative Agreement is based, or any condition or requirement which is specified in Article III; or

3. That action unrelated to surface coal mine reclamation will unreasonably and substantially prevent the mining of Federal coal.

C. *Termination by Operation of Law.* This Cooperative Agreement shall terminate by operation of law when no longer authorized by Federal laws and regulations or Colorado laws and regulations.

D. *Notice or Proposed Termination.* Whenever the Secretary proposes to terminate the Cooperative Agreement he shall:

1. Give written notice to the Governor and to the State Agency;

2. Specify and set out in the written notice the grounds upon which he proposes to terminate the Cooperative Agreement;

3. Specify the date upon which and the place where the State Agency will be afforded an opportunity for hearing and to show cause why the Cooperative Agreement should not be terminated by the Secretary. The date upon which such hearing shall be held shall not be less than 30 days from the date of such notice, and the place of hearing shall be in the State.

4. The Secretary shall also publish a notice in the FEDERAL REGISTER containing the items in 1-3 of this paragraph.

5. Within 30 days of the date of the written notice specifying the date of the hearing, the State Agency may file a written notice with the Secretary stating whether or not it will appear and participate in the hearing. The notice shall specify the issues and grounds specified by the Secretary for termination which the State Agency will oppose or contest and a statement of its reasons and grounds for opposing or contesting. Failure to file a written notice in the Office of the Secretary within 30 days shall constitute a waiver of the opportunity for hearing, but the State Agency may present or submit before the time fixed for the hearing written arguments and reasons why the Cooperative Agreement should not be terminated, and within the discretion of the Secretary may be permitted to appear and confer in person and present oral or written statements, and other documents relative to the proposed termination.

E. *Conduct of Hearing.* The hearing will be conducted by the Secretary. A record shall be made of the hearing and the Governor shall be entitled to obtain a copy of the transcript. The Governor shall be entitled to have legal and technical and other representatives present at the hearing or conference, and may present, either orally or in writing, evidence, information, testimony, document, records, and materials as may be relevant and material to the issues involved.

F. *Notice of Withdrawal of Approval of Cooperative Agreement.* After a hearing has been held, or the right to a hearing has been waived or forfeited by the State Agency, the Secretary, after consideration of the evidence, information, testimony, and arguments presented to him shall advise the Governor of his decision. If the Secretary determines to withdraw approval of the Cooperative Agreement, he shall notify the State Agency of the intended withdrawal and shall afford the State Agency an opportunity to present evidence satisfactory to the Secretary that the State Agency has remedied the specified defects in its administration of the Cooperative Agreement. The Secretary shall state the period of time within which the defects in administration shall be remedied and satisfactory evidence presented to him, and upon failure of the State Agency to do so within the time stated, the Secretary may thereupon withdraw his approval of the Cooperative Agreement without any further opportunity afforded to the State Agency for a hearing.

ARTICLE X—REINSTATEMENT OF COOPERATIVE AGREEMENT

The Cooperative Agreement which has been terminated may be reinstated upon application by the Governor and upon giving evidence satisfactory to the Secretary that the State Agency can and will comply with all the provisions of the Cooperative Agreement and has remedied all defects in administration for which the Cooperative Agreement was terminated.

ARTICLE XI—AMENDMENTS OF COOPERATIVE AGREEMENT

This Cooperative Agreement may be amended by mutual agreement of the Governor and the Secretary. An amendment proposed by one party shall be submitted to the other with a statement of the reasons for such proposed amendment. The party to whom the proposed amendment is submitted shall signify its acceptance or rejection of the proposed amendment, and if rejected

shall state the reasons for rejection. Upon acceptance by the Governor and the Secretary, the amendment shall be adopted after Federal rulemaking.

ARTICLE XII—CHANGES IN STATE OR FEDERAL STANDARDS

The Secretary of the Interior or the State of Colorado may from time to time revise and promulgate new or revised reclamation requirements or enforcement and administration procedures. The Secretary and the State Agency shall immediately inform the other of any final changes in their respective laws or regulations. Each party shall, if it determines it to be necessary to keep this Cooperative Agreement in force, change or revise its respective laws or regulations. For changes which may be accomplished by rulemaking, each party shall have six months in which to make such changes. For changes which require legislative authorization, each party has until the close of its next legislative session at which such legislation can be considered in which to make the changes. If such changes are not made, then the termination provision of Article IX may be invoked.

ARTICLE XIII—QUALIFICATIONS AND EXPERIENCE OF PERSONNEL

The State Agency shall be adequately staffed with, or have readily available to it an adequate number of qualified personnel to carry out fully the requirements of the Cooperative Agreement. The personnel of the State Agency shall be so qualified that the end result of their efforts is comparable to that which would have resulted from administration by Department of the Interior personnel.

ARTICLE XIV—CONFLICT OF INTEREST

No employee of the State Agency responsible for the administration of the State law and rules and regulations relating to this Cooperative Agreement shall participate in the review, analysis, administration, decision-making, or enforcement actions relating to any operation subject to this Cooperative [illegible] in which such person has a direct or indirect financial interest in a company, partnership, organization, or corporation (parent or subsidiary) which owns, operates or has a financial interest in such operation subject to this Cooperative Agreement.

ARTICLE XV—EQUIPMENT AND LABORATORIES

The State Agency shall have equipment, laboratories, and facilities with which all inspections, investigations, studies, tests, and analyses which are necessary to carry out the requirements of the Cooperative Agreement can be performed or determined or have access to such facilities.

ARTICLE XVI—EXCHANGE OF INFORMATION

A. *Organizational and Functional Statement.* The Governor and the Secretary shall advise each other of the organization, structure, functions, and duties of the offices, departments, divisions, and persons within their organizations. Each shall advise promptly the other in writing of changes in personnel, officials, heads of departments or divisions, or a change in the function or duties of persons occupying the principal offices within the organization. The State Agency and the Secretary shall advise each other in writing the location of its various offices, addresses, telephone numbers, and the names, location, telephone numbers of their respective mine inspectors and the area within the State for which such inspectors are responsible, and shall advise promptly of any changes in such.

B. *Laws, Rules and Regulations.* The Governor and the Secretary shall provide to each other copies of their respective laws, rules, regulations and standards, pertaining to the enforcement and administration of this Cooperative Agreement and promptly furnish copies of any final revision of such laws, rules, regulations, and standards when the revision becomes effective.

ARTICLE XVII—RESERVATION OF RIGHTS

This Cooperative Agreement shall not be construed as waiving or preventing the assertion of any rights the State of Colorado and the Secretary may have under the Mineral Leasing Act, the Constitution of the United States, or the Constitution or laws of the State of Colorado.

RICHARD D. LAMM,
Governor,
State of Colorado.

CECIL D. ANDRUS,
Secretary,
Department of the Interior.

MAY 12, 1977.

[FR Doc.77-18396 Filed 6-27-77;8:45 am]

Title 36—Parks, Forests, and Public Property

CHAPTER II—FOREST SERVICE, DEPARTMENT OF AGRICULTURE

PART 211—ADMINISTRATION

Administrative Review Procedures

AGENCY: Forest Service, USDA.

ACTION: Final rule.

SUMMARY: This document revises the administrative review procedures of the Forest Service by deleting regulation 36 CFR 211.2 and substituting new material in 36 CFR 211.19. The revision is designed to improve the review process by modifying time periods and clarifying the appeal stages and appropriate documents involved.

EFFECTIVE DATE: June 28, 1977.

FOR FURTHER INFORMATION CONTACT:

Don D. Seaman, Range Management Staff, Forest Service, P.O. Box 2417, Washington, D.C. 20013, telephone 703-235-8139.

SUPPLEMENTARY INFORMATION: The proposed revision was published for comment on December 13, 1976 (41 FR 54200). Interested parties were given until January 17, 1977, to submit written data, views, or objections pertaining to the proposed revision. Significant changes include the following: (1) Clarification of appeals on procedural matters; (2) clarification of notification requirements when a decision is made; (3) modification of time limits; (4) deletion of formalized reconsideration as an appeal procedure; (5) clarification of the oral presentation procedure, including its discretionary character; and (6) clarification of provisions for multiple party participation in the review process.

The comments filed in response to the notice of proposed revision have been carefully considered. Many of the suggested clarifications and modifications concerned syntax, format, and grammatical consistency. More substantive comments submitted and results of their consideration are summarized as follows:

Comment. The regulations are too restrictive as to time periods and do not allow appellants adequate opportunity for discovery, filing of motions, and participation in more formally structured oral hearing procedures; matters subject to review are too limited by the language "any written decision."

Response. Time periods for filing appeals and related documents are consistent with those of the preceding regulation (36 CFR 211.2) which was found in practice to be reasonable to both appellants and the Forest Service. In fact, the time periods were made more flexible, in conjunction with specific notification requirements to allow appropriate periods for appellants entitled to specific notice of a decision as distinguished from those whose notification would be in a generalized manner such as media publication. Also, time periods for appealing procedural decisions were extended from 15 to 30 days. While some specific guidelines are necessary for the review procedure to function effectively, it is not intended to be an adjudicatory process with attendant formalized discovery and adversary procedures. The regulation refines an informal process accessible to a wide variety of potential appellants, with a minimum of legalistic procedures. Paragraph (a) was revised to expand the matters subject to review beyond decisions which are "written," because it was recognized that not all decisions which may be appealable are reduced to writing.

Comment. Reconsideration should be retained in the regulation to allow the Forest Officer the opportunity to change a decision before it is necessary to go through the whole appeal process.

Response. Deletion of this procedure does not prohibit a Forest Officer from discussing a decision with a potential appellant and reconsidering informally, thus obviating the need for proceeding with a full appeal. However, experience under the superseded regulation (36 CFR 211.2) has indicated that formalized reconsideration often operates to delay the final decision, while duplicating other measures which serve equally well to create a record and clarify the issues in dispute.

Comment. Appeal papers should not be submitted to the officer who made the decision because his objectivity is questionable.

Response. The deciding officer has the authority regarding any rulings on the appeal. Because he made the disputed decision he is familiar with the record and is the logical person to assemble the necessary documents for transmittal to the Reviewing Officer.

Comment. The appeal record should be defined.

Response. A new paragraph (1) has been added, specifying those documents which comprise the administrative review record.

Comment. The regulation should provide for appeal to the Secretary of a

SECTION 3:

Archeology

Table 1: Consultation Efforts with Academic Institutions and Museums to Learn of Unpublished Surveys or Excavations in the Study Region

Table 2: Consultation Efforts with Academic Institutions and Museums to Verify Whether Cherokee Indians had Traveled in the Study Region in 1848 or 1849

SECTION 3

TABLE 1

CONSULTATION EFFORTS WITH ACADEMIC INSTITUTIONS AND MUSEUMS TO LEARN OF UNPUBLISHED SURVEYS OR EXCAVATIONS IN STUDY REGION

Institution or Museum	Response or Results
Department of Anthropology The American Museum of Natural History Central Park West at 79 St. New York City	No work recorded
Department of Anthropology and Archaeology, Brigham Young University, Provo, Utah	No response
Department of Anthropology University of Denver, Denver, CO	No response
Department of Anthropology University of Utah, Salt Lake City	Acquired copy of E.R. Smith's fieldnotes
Department of Anthropology Field Museum of Natural History Roosevelt Rd and Lake Shore Drive Chicago, Illionis	No response
Lowie Museum of Anthropology Universtiy of California, Berkeley	No work recorded
Museum of the American Indian Heye Foundation Broadway at 155th St. New York	No work recorded
Museum of Northern Arizona Flagstaff, Arizona	No work recorded
Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, Massachusetts	Acquired copies of accession cards for Colorado artifacts including catalogue number for artifacts from the 1933 Dubois Expedition within Dinosaur National Monument
The Peabody Museum of Natural History, Yale Universtiy, New Haven, Connecticut	No work recorded
R.S. Peabody Foundation for Archaeology, Andover, Massachusetts	No response

TABLE 1 (Cont.)

CONSULTATION EFFORTS WITH ACADEMIC INSTITUTIONS AND MUSEUMS TO LEARN OF UNPUBLISHED SURVEYS OR EXCAVATIONS IN STUDY REGION

Institution or Museum	Response or Results
School for American Research Santa Fe, New Mexico	No response
Smithsonian Institution Washington, D.C.	Only recent records are available at the Smithsonian; earlier records are in document storage or at the Washington D.C. office of the National Park Service
Wyoming Recreation Commission Office of the Wyoming State Archeologist University of Wyoming, Laramie, Wyoming	No work recorded

TABLE 2

CONSULTATION EFFORTS WITH ACADEMIC INSTITUTIONS AND MUSEUMS TO VERIFY WHETHER CHEROKEE INDIANS HAD TRAVELED IN THE STUDY REGION IN 1848 OR 1849

Institution or Museum	Response
Department of Sociology and Anthropology Applachian State University, Boone, North Carolina	Could not provide any information to verify whether or not Cherokee were in the study region
Museum of the Cherokee Indian, Cherokee, North Carolina	No response
Department of Anthropology University of North Carolina, Chapel Hill, North Carolina	No response
Department of Anthropology University of Oklahoma Norman, Oklahoma	Considered that such an event was unlikely

SECTION 4

Historic Resources:

Table 1: Historic Resources Within the Northwest Supplemental Report Area

Table 2: Sites Recorded Since 1975 That Do Not Appear to Qualify for the National Register of Historic Places

TABLE 1

HISTORIC RESOURCES WITHIN THE NORTHWEST SUPPLEMENTAL REPORT AREA

Name of Site	Site Number	Principal Site Feature	Integrity 1/	Condition 2/	Historic Significance 3/	Physical size (in ac/mi)	Ownership or Management
White City, Colorado	LS-020	Townsite	Good	Fair	S, L	480	Private
Cow camp on Wolf Creek	LS-051	Campsite	Fair	Fair	L	1	NRL
Grave of Isom Dart	LS-050	Grave	Unknown	Unknown	L	.05	Colorado
Thornburgh Wagon Road	LS-017	Road	Fair	Fair	S, L	234	Pvt/NRL/Colorado
Great Divide Townsite	LS-019	Townsite	Fair	Fair	S, L	10	Private/NRL
Fortification Hall	LS-018	Building	Fair	Fair	L	.05	Private
Matt Trail	LS-012	Trail	Fair	Fair	L	23	NRL
Powderwash, Colorado	LS-014	Townsite	Good	Good	L	25	NRL
Wolf Creek Cabin	LS-016	Cabin	Poor	Poor	L	.05	Private
Winslow Ranch	LS-008	Ranch	Fair	Fair	L	3	Private
Grandt Homestead	LS-009	Homestead	Fair	Poor	L	1.5	NRL
Great Northern Ditch	LS-011	Canal	Poor	Poor	S, L	88	Private/NRL
Choke Cherry Gulch	LS-013	Homestead	Fair	Fair	L	2	NRL
George Iles Ranch	LS-001	Ranch	Fair	Fair	L	3	Private
Duffy Mountain Tunnel	LS-003	Tunnel	Fair	Fair	L	2	NRL
Randolph & Johnson Homesteads	LS-004	Homesteads	Fair	Good	L	6	NRL
Big Hole Gulch Cabin	LS-005	Homestead	Fair	Fair	L	3	Private
Blue Gravel Encampment	LS-006	Military Encampment	Poor	Poor	S, L	3	Private
Government Bridge	LS-007	Bridge	Fair	Fair	L	.05	Private
Lay, Colorado	N/A	Townsite	Fair	Fair	L	5	Private
Hahn's Peak, Colorado	N/A	Townsite	Fair	Fair	S, L	25	Private
Juniper Hot Springs, CO	N/A	Townsite	Good	Fair	L	10	Private
Denver & Salt Lake/Denver & Rio Grande Western Railroad (D&SL)	N/A	Railroad	Good	Good	S, L	200 mi.	Private
Victory Highway (US 40)	WR-002	Highway	Fair	Poor	S, L	132 mi.	NRL/Private
Cabin on Wolf Creek	WR-010	Cabin	Fair	Poor	L	1	Private
Cabin on Wolf Creek	WR-015	Cabin	Fair	Fair	L	1	NRL
Homestead on White River	WR-032	Homestead	Fair	Fair	L	2	Private
Homestead on White River	WR-031	Homestead	Fair	Poor	L	4	NRL
Jack Springs, Colorado	SC-001	Townsite	Fair	Poor	L	3/4	Private
Cabin at Jack Springs	SC-002	Cabin	Poor	Poor	L	1	Private
Stoner Cabin	SC-003	Cabin	Fair	Poor	L	1	Private

1/, 2/, 3/ See following page for footnotes.

TABLE 1 (Cont.)

HISTORIC RESOURCES WITHIN THE NORTHWEST SUPPLEMENTAL REPORT AREA

Name of Site	Site Number	Principal Site Feature	Integrity 1/	Condition 2/	Historic Significance 3/	Physical size (in ac/mi)	Ownership or Management
Graham Homestead	SC-004	Cabin	Poor	Very Poor	L	1	Private
Radium Mine Cabin	SC-005	Mine	Fair	Poor	L	1	Private
Radium Mine Cabins	SC-006	Buildings	Fair	Poor	L	2	Private
Radium Mine Tipple	SC-007	Mine Tipple	Good	Good	L	2	NRL
Skull Creek, Colorado	SC-008	Townsite	Good	Good	L	5	Private
Corral and Dugout	SC-009	Corral	Fair	Poor	L	1	Colorado
Miller Homestead	SC-010	Cabin	Poor	Poor	L	2	NRL
Jones Homestead	SC-011	Homestead	Good	Good	L	5	Private
Shelton Homestead	SC-012	Corral and Barn	Poor	Ruins	L	2	Private
Mansfield Cabin	SC-015	Cabin	Fair	Fair	L	2	Private
Willow Creek Bridge	SC-016	Bridge	Good	Good	L	.05	NRL
Thornburgh Battle Site	N/A	Battlesite	Fair	Fair	S, L	10	Private/NRL
Meeker, Colorado	N/A	Townsite	Fair	Fair	S, L	40	Private
White River Agency Site	N/A	Townsite	Poor	Poor	S, L	20	Private

1/ Integrity refers to the historical condition of a site -- its present condition, past condition and present setting. A site with "good" integrity would appear virtually as it was when it was constructed or occupied, while a site with "poor" integrity would be either totally obliterated or so substantially modified that it would no longer be recognizable.

2/ Condition refers to the present physical condition of a historical site -- the condition of the structure(s) or area of the site, including any evidence of vandalism that is present, the condition of architecture, and the condition of the land around the site. A site in "good" condition would have a building with excellent structural condition; the land around it would be nearly like the original; and there would be no signs of vandalism. A site in "poor" condition would shown signs of decay; the land might be modified; and there might be signs of human or animal intrusion.

3/ N = national, S = state, L = local significance

TABLE 2

SITES RECORDED SINCE 1975 THAT DO NOT APPEAR TO QUALIFY FOR THE NATIONAL REGISTER OF HISTORIC PLACES

Site Designation	Site Description
5 RT 15	Remains of Wooden Structure. Recorded in 1975 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register. Private Land.
5 RT 26	Remains of a log cabin. Recorded in 1975 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register. Private Land.
5 RT 21	Remains of historic dugout. Recorded in 1975 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register of Historic Places. Private Land.
5 MF 319	This site consists of ruins of a log and sandstone cabin. Recorded in 1975 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register of Historic Places. Private Land.
5 MF 323	This site consists of the ruins of a log cabin and one outbuilding. Recorded in 1975 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register of Historic Places. Private/BLM Land.
5 RT 35	This site consists of three wooden buildings. One structure, a barn is unique to the area and may qualify for the National Register of Historic Places. Recorded in 1975 by C. Jennings, Colorado State University. Private Land.
5 MF 348	Small milled lumber shack. Recorded in 1975 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register of Historic Places. Private Land.
5 RT 12	Milled lumber house with outbuildings. Recorded by C. Jennings, Colorado State University in 1975. This site does not appear to qualify for the National Register of Historic Places. Private Land.
5 RT 16	This site consists of a log cabin with several ruined outbuildings. Recorded in 1975 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register of Historic Places. Private Land.
5 RT 17	This site consists of a log house with a gable roof and one ruined outbuilding. Recorded in 1975 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register of Historic Places. Private Land.

TABLE 2 (Cont.)

SITES RECORDED SINCE 1975 THAT DO NOT APPEAR TO QUALIFY FOR THE NATIONAL REGISTER OF HISTORIC PLACES

Site Designation	Site Description
5 RT 25	This site consists of 3 buildings including a milled wood house, one log barn and a collapsed log outbuilding. Recorded in 1975 by C. Jennings, Colorado State University, it no longer exists. Private Land.
5 MF 336	This site consists of a rock foundation. Recorded in 1975 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register of Historic Places. Private Land.
5 MF 331	This site consists of a small dugout. Recorded in 1976 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register of Historic Places. Private Land.
5 MF 329	This site consists of the ruins of four structures. Recorded in 1976 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register of Historic Places. Private Land.
5 MF 328	This site consists of the ruins of a log structure with a sandstone foundation. Recorded in 1975 by C. Jennings, Colorado State University. This site does not appear to qualify for the National Register of Historic Places. Private Land.

SECTION 5:

Aquatic Biology: Addendum to the Species List in Table IX-1 in the Northwest Colorado Coal Regional Environmental Statement

SECTION 5

AQUATIC BIOLOGY: ADDENDUM TO THE SPECIES LIST IN TABLE IX-1 IN THE NORTHWEST COLORADO COAL REGIONAL ENVIRONMENTAL STATEMENT

	Scientific name	Habitat preference	Spawing period	Status of species in analysis area
Common shiner	Notropis cornutus frontalis	Prefer medium sizes streams wtih clear water	May and June (on gravel riffles	Common in warm water reservoirs and larger streams
Fathead minnow	Pimephales promelas	Common in streams and reservoirs of eastern Colorado. Tolerates muddy waters well. Has been found at altitudes over 9,500 feet.	Late spring to mid summer	Common in warm water reservoirs and larger streams
Mountain sucker	Pantosteus discobolus	Predominately a head-water stream fish, prefers streams with gravelly bottoms.	Spring	Common in upper mountain streams and reservoirs.

SECTION 6:

COLORADO WATER QUALITY STANDARDS FOR CLASS B_1 AND B_2 WATERS

SECTION 6:

COLORADO WATER QUALITY STANDARDS FOR CLASS B_1 AND B_2 WATERS

(1) State waters designated class B_1 or B_2 are waters suitable or to become suitable for all purposes for which raw water is customarily used, except primary contact recreation, such as swimming and water skiing.

(2) Water in class B_1 exhibits or is to exhibit the following characteristics:

a. Bacteriological concentrations do not exceed a geometric mean of 10,000 total coliform groups or 1000 fecal coliform groups per 100 milliliters based on a minimum of not less than five samples obtained during separate 24-hour periods for any 30-day period, nor do 10 percent of the fecal coliform samples exceed 2000 groups per 100 milliliters during any 30-day period.

b. The dissolved oxygen concentration is not less than 6 milligrams per liter.

c. A pH rating of not more than 9.0 nor less than 6.0 units.

d. Temperature maintains a normal pattern of diurnal and seasonal fluctuations and does not change abruptly. No warming discharge is permitted in the hypolimnion of lakes. Temperature is not increased above 68^{o} F. by any means other than natural means, nor is temperature increased in streams and in the epilimnion of lakes or reservoirs more than 2^{o} F. by any discharge.

e. Wastes of other than natural origin does not cause the turbidity of the water to be increased by more than ten Jackson Units or its equivalent.

(3) Water in class B_2 exhibits or is to exhibit the following characteristics:

a. Bacteriological concentrations do not exceed a geometric mean of 10,000 total coliform groups or 1000 fecal coliform groups per 100 milliliters based on a minimum of not less than five samples obtained during separate 24-hour periods for any 30-day period, nor do 10 percent of the fecal coliform samples exceed 2000 per 100 milliliters during any 30-day period.

b. The dissolved oxygen concentration is not less than 5 milligrams per liter.

c. A pH rating of not less than 6.0 nor more than 9.0.

d. Temperature maintains a normal pattern of diurnal and seasonal fluctuations and does not change abruptly. No warming discharge is permitted in the hypolimnion of lakes or reservoirs. Temperature is not increased above 90^{o} F. by any means other than natural means, or is temperature increased by discharges more than 5^{o} F. in streams and more than

3^{o} F. in the epilimnion of lakes or reservoirs.

e. Wastes of other than natural origin does not cause the turbidity of the water to be increased by more than ten Jackson Units or its equivalent.

APPENDIX B

Bibliography

Glossary

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The following are addenda to the Glossary of the Northwest Colorado Coal Regional Evnironmental Statement (NWCCRES, January 1977), covering terms employed in the Northwest Supplemental Report that are not defined there.

Adit. A nearly horizontal passage from the surface by which a mine is entered, unwatered, or ventilated. An adit in the U.S. is also called "drift" or "adit" level.

Air pollution dispersion potential. A qualitative assessment of the likelihood that a pollutant released into the atmosphere will be dispersed (diluted). See mixing height, transport winds, ventilation.

Airsheds. These are areas in which weak dispersion conditions result from the effects of obstructions on the normal wind flow pattern. These obstructions are elevated topographic features, such as mountain ranges or canyon walls.

Albedo. The capacity of a surface to reflect light or electromagnetic radiation.

Ambient. The natural conditions (or environment) at a given place and time.

Ambient air quality. The state of the atmosphere at ground-level as defined by the range of measured and/or predicted ambient concentrations of all significant pollutants for all averaging periods of interest.

Ambient concentrations. Ground-level pollutant concentrations resulting from all anthropogenic and natural pollutant sources.

Assessed values. The value of all property within a taxing jurisdiction (e.g., a community, school district, or county). Assessed value is assigned for tax purposes and will not correspond to actual market value.

Atmospheric dispersion model. A mathematical simulation of the atmospheric transport and dispersion of pollutants used to predict pollutant concentrations.

Atmospheric temperature lapse rate. The decrease of temperature with height. The standard lapse rate is $-5.4^{\circ}F$ per 1,000 feet of rise.

Average daily attendance entitlement (ADAE). The sum of the daily attendance for a period of time divided by the actual number of days of school taught during that time, or 96 percent of the average daily membership during a four-week counting period in the year immediately preceding the budget year. It is used in determining attendance entitlements (AEs) by which the authorized revenue base of a district for a subsequent fiscal (calendar) year is figured.

Base flow. Streamflow derived from ground water discharge into the waterway.

Baseline concentrations. Ground-level pollutant levels resulting from anthropogenic or natural sources. In this study, pollutant concentrations predicted using atmospheric dispersion models are not included in the baseline.

Blizzard. A severe weather condition characterized by low temperatures and by strong winds bearing a great amount of snow (mostly fine, dry snow picked up from the ground). The criteria for identifying a blizzard condition are (1) winds 32 mph or higher, (2) low temperatures, and (3) sufficient snow in the air to reduce horizontal visibility to less than 500 feet.

Bonded indebtedness. The amount of money a community (or other jurisdiction) owes as a result of issuance of bonds.

Centralized traffic control (CTC) signalization. A computerized system of signalization by which movements of trains over routes on a designated section of tracks can be directed by signals and controlled from a designated point without requiring the use of train orders and without superiority of trains.

C.L.I. Canadian Land Inventory - a land capability classification system for outdoor recreation.

Cold air drainage. A wind (or component thereof) directed down the slopes of an incline and caused by greater air density near the slope than at the same levels some distance horizontally from the slope. This term usually is applied when the density difference is produced by surface cooling along the incline.

Concentration isopleth. Line connecting points of equal pollutant concentration.

Constant dollars. Monetary figures which have been adjusted to account for inflation so that the purchasing power in different years remains constant.

Critical winter range. Areas within winter range where game animals are confined during periods of heaviest snowfall. Special management consideration for maintaining or improving the habitat is given to these areas to sustain populations of game animals.

Cyclonic. An atmospheric circulation marked by counterclockwise flow of winds in the northern hemisphere.

Deposition. The depletion of particulate matter from a dispersing pollutant plume due to gravitational settling, surface impaction, electrostatic attraction, and absorption.

Dispersion. The distribution or dillution of a given quantity of pollutant in an increasing volume of atmosphere. Dispersion is regulated mainly by the intensity of the turbulent mixing of the air, with only a slight contribution from molecular diffusion.

Dispersion potential. The ability of the atmosphere to dilute or disperse air pollutants, as determined by normal ventilation values. A high dispersion potential results from high ventilation values, which can be caused by high transport wind speeds, high mixing heights, or high values of both.

Dispersion sub-area. A geographical region such as a valley or canyon with similar atmospheric dispersion patterns throughout.

Downslope flow. A wind blowing downhill or downvalley.

Drainage basins. Low-lying areas where cold air drainage is prominent during nighttime conditions of clear skies and light winds.

Drainage flow. A wind blowing downhill or downvalley, caused by radiational cooling of the air along hill or mountain slopes. See cold air drainage.

Drainage wind. Same as drainage flow.

Drought. A period of abnormally dry weather sufficiently prolonged for the lack of water to cause a serious hydrologic imbalance (i.e., crop damage, water-supply shortage, etc.). A year during which the precipitation measures 75% or less of the normal annual precipitation is sometimes called a drought year.

Eh. Redox potential. The terms redox potential, oxidation potential, and oxidation-reduction potential are interchangeably used in water chemistry to present the relative intensity of oxidizing or reducing conditions in solutions. The sign convention used for these potentials in natural-water chemistry results in relatively oxidizing systems being assigned positive potentials and reducing systems being assigned negative ones. Oxidized rocks are generally more stable and subject to less leaching than reduced rocks. Acids are formed primarily when reduced rocks are exposed by mining to oxygen in the given atmosphere.

Emission factor. An empirically derived mathematical relationship between pollutant emission rate and some characteristic of the source such as volume, area, mass, or process output.

Ephemeral stream. A stream that flows only for a part of the year or in a direct response to snowmelt or storm runoff.

Extrapolation. The projection or extension of data into an area with no data.

Extratropical. Originating outside of the tropical regions.

"Extreme mile". The "extreme mile" wind, or the fastest mile, is the fastest speed, in miles per hour, of any "mile" of wind that passes a stationary point.

Fastest mile. See "extreme mile".

Fugitive dust. A type of particulate emission made airborne by forces of wind, man's activity, or both, such as unpaved roads, construction sites, tilled land, or windstorms.

Growing season. Generally, the period of the year during which the temperature of cultivated vegetation remains sufficiently high to allow plant growth.

Hail. Precipitation in the form of balls or irregular lumps of ice, always produced by convective clouds, nearly always cumulonimbus (thunderstorm cloud).

Heterogeneous terrain. Land characterized by irregular terrain.

Human interest value. Those elements, aspects, or man-made changes in the landscape that challenge the mind or excite the curiosity.

Hydrologic imbalance. The alteration of the normal water cycle, such as that produced during a drought or a very wet period. In the case of the former, a water-supply shortage results as well as crop damage.

Insolation. Solar radiation received at the earth's surface.

Interburden. All of the earth and other materials that lie between two beds of minerals.

Interpolation. The estimation of unknown intermediate values of a variable from known values.

Isohyet. Isopleth of precipitation amounts.

Isopleth. A line on a map connecting points at which a given variable has the same value. An isopleth of precipitation is called an isohyet.

Isopluvial. A line drawn through geographic points having the same pluvial index.

Isotherm. An isopleth of temperature.

Large-scale flow. Same as synoptic-scale flow.

Leachate. Percolating liquid containing dissolved constituents leached from spoil materials.

Legal debt limit. The maximum amount of bonded indebtness that a community (or other jurisdiction) may incur under state law. This is typically expressed as a percentage of the community's assessed value.

Mean annual temperature. The average yearly temperature at a site, computed by the averaging of daily maximum and daily minimum temperatures during each year for numerous years of data.

Mean monthly temperature. The average monthly temperature at a site, computed by the averaging of daily maximum and daily minimum temperatures during each month for numerous months of data.

Mean recurrence interval. The average time it takes before a certain event occurs again. This is applied to such parameters as strong winds and heavy rainfall.

Mechanical mixing. Mixing of the air by mechanical turbulence.

Mechanical turbulence. Turbulence produced by friction of passage of a fluid over a surface. It is more pronounced over rough surfaces and with flow around objects and is directly proportional to flow velocity. In this report, this term is used in the context of air motions over terrain features.

Micromhos/cm. A measure of specific conductance expressed in micromhos per centimeter at 25°C. It is one million times the reciprocal of specific resistance at 25°C. Specific resistance is the resistance in ohms of a column of water one centimeter long and one square centimeter in cross section. Because the specific conductance is related to the number and specific chemical types of ions in solution, it can be used for approximating the salinity of water.

Mixing heights. The height above the ground to which turbulence causes the air to be well mixed.

Modeling. A mathematical or physical representation of an observable situation. In air pollution control, models afford the ability to predict pollutant distribution or dispersion from identified sources for specified weather conditions.

Mood atmosphere. The total, overall aesthetic experience resulting from perception of one's environment though all senses.

Orographic lifting. The vertical movement of air as a result of the deflecting influence of a topographical barrier (such as a mountain) on a horizontally moving stream of air.

Paleoecological. Of or relating to paleoecology, the relation of prehistoric plants and animals to their environment and with the characteristics of prehistoric environments.

Pergelic. Of or pertaining to the temperature regime of soils, characterized by a mean annual temperature of lower than 0°C. These soils have permafrost if they are moist or dry frost if excess water is not present.

Personal income. All forms of income received by persons in an area -- wages and salaries, profits of those who own business, social security, employer contribution to pension plans, etc.

Pluvial index. The amount of precipitation falling in one day, or other specified period, that is likely to be equalled or exceeded at a given place once in a century (or a shorter geological time period).

Point probability. The probability that any one specific location will experience a certain event. When calculating the point probability of a tornado occurrence, the following are taken into account: (1) the frequency of tornadoes over a specific area, (2) the physical dimensions of that same area, and (3) the average swath (surface width and length of the path) covered by a typical tornado (this is a single value for the region concerned, and Thom's value is generally used as a yardstick value for comparing probabilities at various locations in the contiguous U.S.).

Point source. A pollutant source whose origin of emissions can be approximated by a single point.

Precipitable water. The total atmospheric water vapor contained in a vertical column of unit cross-sectional area extending between any two specified levels (such as surface to 20,000 feet), commonly expressed in terms of the height to which that water substance would stand if completely condensed and collected in a vessel of the same unit cross-section.

Predicted concentrations. Ground-level atmospheric pollutant levels calculated using atmospheric dispersion models.

Prevailing wind. The most frequent compass direction from which the wind blows.

Radiational cooling. The cooling of the earth's surface and adjacent air, accomplished (mainly at night) whenever the earth's surface suffers a net loss of heat.

Receptor. An imaginary point for which pollutant concentrations are predicted.

Recurrence interval. See mean recurrence interval.

Regional visibility. Visibility predicted to occur in the region around a source or group of sources resulting from annual average particulate concentrations in the vicinity of these sources.

Relative humidity. The ratio of the amount of water vapor actually present in the air to the greatest amount possible at the same temperature.

Revegetation. The provision of barren land with a new vegetative cover.

Runoff. The water derived from precipitation that ultimately reaches stream channels.

Sector (socioeconomic). A grouping of industries with similar characteristics. For example, tne retail trade sector or the mining sector.

Semiarid climate. In Thornthwaite's 1931 climatic classification, a humidity province whose principal plant life is short, drought resistant grasses. Köppen called these conditions the "steppe climate". Semiarid regions are highly susceptible to severe drought.

Site-specific. Pertaining to a certain location; not necessarily representative of a large area.

Snowpack. A seasonal accumulation of slow-melting packed snow.

Steady-state Gaussian dispersion equation. A formula relating vertical and horizontal pollutant concentration distributions to source strength, source geometry and meteorological conditions. This equation is based on the assumption of Gaussian or normal concentration distributions in the vertical and horizontal cross wind directions and the assumption of non-varying meteorological and source conditions.

Syncline. A trough of stratified rock in which the beds dip towards each other from either side.

Synoptic-scale. The scale of high and low pressure systems in the lower layers of the atmosphere. This scale is generally considered to range from 600 miles to 1,500 miles.

Thermal turbulence. Turbulence produced by heating a fluid from beneath to cause density turnover. In this report, thermal turbulence means heating of the air near the earth's surface and vertical mixing of the unstable layer that is created by the heating from below.

Tilth. The state of aggregation of a soil. This term is usually applied to soil tilled for planting. Good tilth implies a good tillable soil with no excess of either fine or coarse fractions.

Topographical adjustment. The construction of isopleths for a certain parameter (such as temperature, precipitation, or snowfall) by the combined use of both topographical data and data for that parameter.

Total suspended particulates. The portion of the total particulate matter in the atmosphere consisting of particles so small that the particles settle out very slowly.

Transport wind. The average horizontal wind speed component perpendicular to a vertical cross section of the atmosphere. In this report, the vertical limits are defined by the ground and the mixing height.

Turbulence. A state of fluid flow with irregular and apparently random fluctuations of instantaneous velocities. These fluctuations often constitute major deformations of the flow and are capable of transporting momentum, energy, and suspended matter at rates far in excess of the rate of transport by the molecular processes of diffusion and conduction in a non-turbulent flow.

Undifferentiated highlands. Same as highland climate or mountain climate. Very generally, the climate of relatively high elevations. Mountain climates are distinguished by the departure of their characteristics from those of surrounding lowlands, and the one common basis for this distinction is that of atmospheric rarefaction. Aside from this, great variety is introduced by differences in latitude, elevation, and exposure to the sun. Thus, there exists no single, clearly defined mountain climate.

Unit train. A single commodity shipment destined for only one customer. Although unit trains are often referred to as 100-car length trains, the actual length may vary considerably from this amount.

Upslope flow. A wind blowing toward higher elevations.

Ventilation. A measure of the amount of air moving through a vertical cross-section of the atmosphere. The higher the ventilation, the higher the dispersion. As used in this report, it is the product of the mixing height and the transport wind.

Visibility. A measurement of the maximum distance from which large objects may be viewed. Fixed reference objects such as mountains, hills, towers, or buildings are normally used to estimate visibility.

Visit. Participation in a recreational activity for any part of a day.

Visitor day. Participation in a recreational activity for a 12-hour period.

Visual range. Measured or predicted visibility obtained by means other than the direct visual observation of visibility.

Westerlies. Specifically: the dominant west-to-east motion of the atmosphere, centered over the middle latitudes of both hemispheres.

Wind rose. A graphical display of wind speed and wind direction frequencies at a meteorological station. The bar graphs extend into the direction from which the wind blows. These directions are the sixteen compass-point directions (i.e., north, north-northeast, northeast,...., northwest, and north-northwest).

Winter range. Area available to and used by game animals through all or nearly all of the winter during most years.

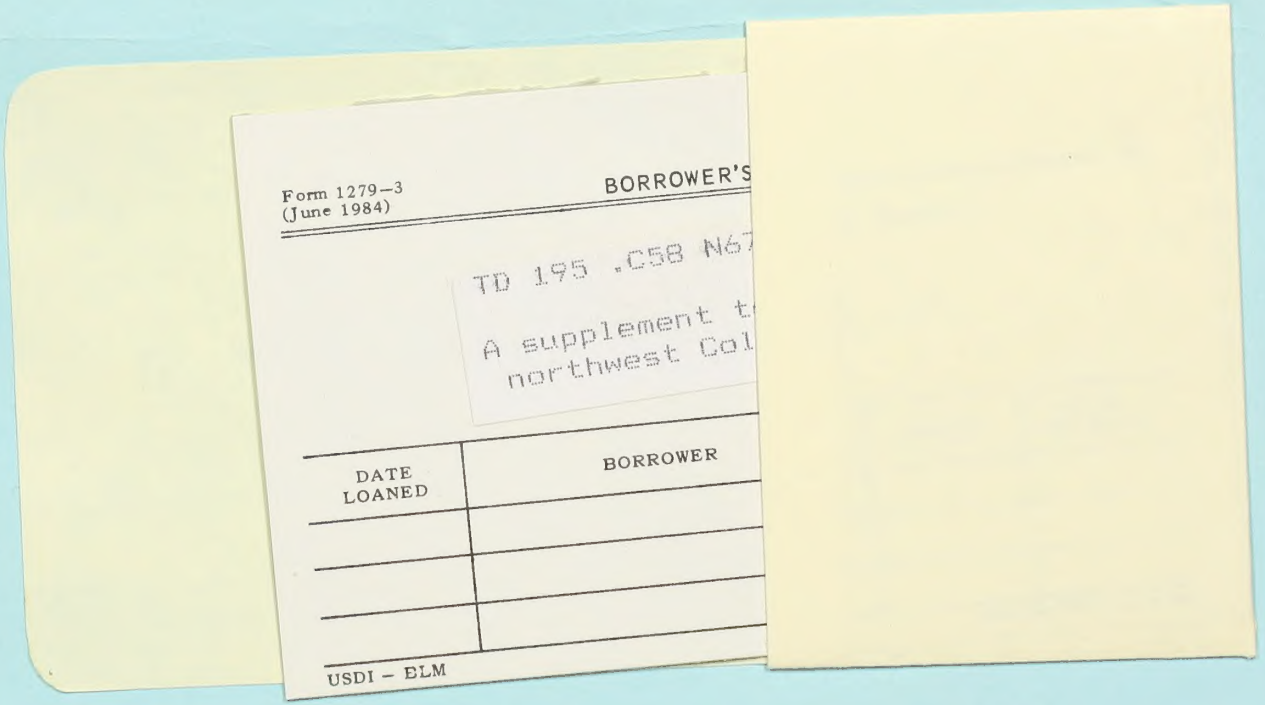
APPENDIX C

Map 1-1: Existing Operations, Proposed Operations, and Areas of Anticipated Development Included in Mid-Level Production

Map 1-2: Existing and Future Operations Included in Low-Level Production

Map 1-3: Existing Operations, Proposed Operations, and Areas of Anticipated Development Included in High-Level Production

* U.S. Government Printing Office: 1978-677-568 Region 8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